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OF THE

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OF LONDON.

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OF THE

ZOOLOGICAL SOCIETY OF LONDON.

1903.

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ZOOLOGICAL SOCIETY OF LONDON

1903, Vol. I. (January to April).

January 20, 1903.

Prof. G. B. Howes, D.Sc., LL.D., F.R.S., Vice-President, in the Chair.

The Secretary read the following report on the additions to the Society's Menagerie during the month of December 1902:—

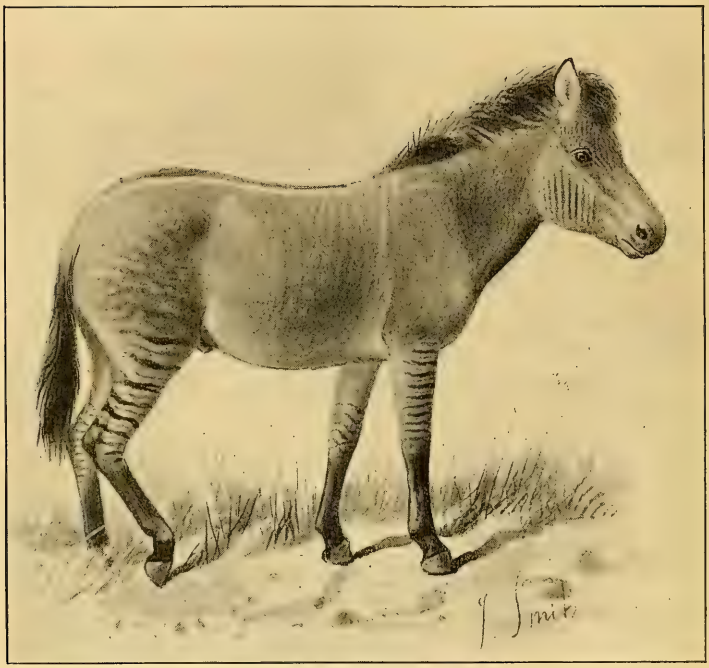
The registered additions to the Society's Menagerie during the month of December 1902 were 30 in number. Of these 15 were acquired by presentation, 1 was born in the Gardens, and 10 were received on deposit and 4 in exchange. The total number of departures during the same period, by death and removals, was 141.

Amongst the additions worthy of notice are two very fine specimens of the One-wattled Cassowary (*Casuarius uniappendiculatus*), from New Guinea, deposited by the Hon. Walter Rothschild, M.P., F.Z.S., on Dec. 30th.

Mr. P. L. Sclater read an extract from a letter from Messrs. Stagmann, Esselen & Roos, of Pretoria, dated Dec. 8th, 1902, and addressed to Major W. H. Birkbeck of the Remount Department, Johannesberg, from which it appeared that the hybrid Zebra, placed under the Society's care by the King on July 19th, 1902

(see P. Z. S. 1902, vol. ii. p. 225), was the progeny of a male Zebra and a pony mare. Major Birkbeck added the following

Text-fig. 1.



Hybrid between *Equus burchelli*, ♂, and *E. caballus*, ♀.

particulars:—The hybrid was rising 12 months in July 1900 when he came in. He went home with a pony of which he was very fond, and if he gets troublesome the company of a quiet pony will pacify him at once. We gelded him, thinking Her Majesty might use him, and a stallion hybrid is always a terror. The late owner Erasmus has tried to claim compensation, but as the beast was a fair capture he has no case at all. At the surrender the Boers kept any horses of ours they had and we, of course, keep theirs.

Mr. J. S. Budgett, M.A., F.Z.S., gave an account of his recent journey to Uganda and return by the Nile, which was illustrated by a large series of photographs taken by him as he went along.

Mr. Budgett made the following remarks:—

The special object of my journey to Uganda was to continue investigations on the life-history of African fishes and especially

of *Polypterus*. Having made previous attempts to solve this problem under certain conditions in a confined area, it was thought that by observing it under varied conditions of latitude and altitude, new light might be brought to bear upon it.

From Uganda it was possible either to work down the Congo from its source or to return northwards down the Nile.

On my way to Uganda, and in Uganda, I gathered what information I could about the two routes. The southern end of the Nile Valley really lies at the foot of Ruwenzori, while a short journey westwards from this point would bring one into the headwaters of the Congo.

A special inducement to take the Congo route was that information might in this journey be obtained about the new animal *Okapia johnstoni*, and other interesting forms, believed to exist in the Semliki Forest.

From information gathered in Uganda, it was clear that it was useless to hope to meet with Okapi in British territory, and, moreover, I here learned that the Belgians had found the Okapi in large numbers in the Welle country.

I found also, what had been very difficult to learn before leaving home, that the season of the rains and the breeding of *Polypterus* were considerably earlier at the source of the Nile than they were further northwards; that the Semliki Valley was a most inconvenient place at which to make a permanent camp by the river-banks, owing chiefly to the scarcity of food; and that only one species of *Polypterus* was to be found there, while at least three species were to be found in the Nile farther to the north.

The difficulty of taking delicate apparatus through the Congo Forest to the upper waters of the Congo was incomparably greater than to the upper Nile.

And, lastly, it was to be borne in mind that the time of year at which one might hope to be successful in the main object was that at which it was well nigh impossible to do much in the way of collecting the higher Vertebrata which might be supposed to be of interest in the Semliki Valley; for at this time the grass is so high that moving away from beaten tracks is almost impossible, while anything smaller than giraffe or elephant is seldom seen. Bearing these facts in mind, I had little hesitation in deciding to work down the Nile, striking it at a point farther northwards than the Semliki River, in order to take advantage of the lateness of the season in that region. Accordingly, having fitted out my safari or caravan at Entebbe, I started for Butyaba, on the west coast of Lake Albert, on July 10th. I had the advantage of starting thus along a good road which had just been cleared for the greater part of the way, and along which the rest-houses had been repaired for the convenience of the Commissioner and Consul-General of British East Africa, Sir Charles Eliot, who has recently made such a remarkably rapid journey from Entebbe to Gondokoro, the frontier station of Uganda on the Upper Nile.

At Kampala I diverged, however, for a few days along the old road to Massindi to the eastward.

I had with me at the start 50 men and boys and my bicycle.

So many books have been written on Uganda, that there is little need to describe the scenery of these tropical highlands, especially as Sir Harry Johnston's wonderfully complete book is now in everybody's hands.

Shortly, one may say that, on going northwards from Lake Victoria, forest is hardly seen after leaving Kampala. We passed day after day through almost endless elephant-grass, with palm-groves and papyrus-swamps in the lower parts. The hills are clothed with clumps and patches of acacia and euphorbias, while their summits are very frequently covered with huge granite boulders. There were thunderstorms and rain every afternoon, and for the first few days I saw little in the way of animal life: occasionally a Civet cat would cross the path, while overhead Hornbills and Plantain-eaters of various species were common. In the valley of the Maangia for a time we were rid of the everlasting elephant-grass, and here *Cobus thomasi* and Zebra were plentiful. The *Cobus thomasi* of this region is somewhat different to that met with in the valley of the Nile, the horns having a wider curve and being stouter and of a lighter colour, while the animal itself is of a larger build and has more brilliant markings.

The Maangia River flows northward through wide undulating plains, covered at this time with hay-like grasses upwards of five feet in height, and dotted over with very fine acacias, of a cedar-of-Lebanon appearance and of richest deep-green colour. The grasses and bushes of the roadside teem with bird-life: as we rode along, the little *Vidua principalis*, with his dozen sombre wives, was a constant companion, flitting just ahead of us for a mile or more along the road. Likewise the Common Shrike of these parts (*Lanius excubitorius*) has exactly the same habit of driving along in flocks with a caravan as the *Corvinella corvina* of the West Coast. In the marshy parts, *Scopus umbretta* was often seen.

Then, leaving the plain, we struck up over the Bukamva hills, and at the crest dived into the dense grass at the side of the road, to travel for four weary hours over a wretched and little-used track, often obliterated by the tramp of elephants, and where it was quite impossible to make any progress with the bicycle. Then, descending rapidly by swampy valleys and thick jungle, we came suddenly into the new road to Hoima and Butyaba. From here to Hoima the road crossed the steep hills which form the boundary between Uganda and Unyoro, passing by abundant plantations of bananas and through many a lovely valley, at the bottom of which a stream ran through the richest vegetation, the banks carpeted with Cannas, winter cherries, and hemlock, while overhead were many *Pterocarpus*-trees with blossoms like the Alamanda flower. As I did not care to get too far from my safari, I would often

bicycle on for an hour, and then sit down in one of these shady spots, and watch the Mouse-birds hanging like acrobats in attitudes most quaint, and Sun-birds darting in and out of the great red blossoms of the *Spathodea*, while often a noisy flock of *Prionops plumatus* passed hurriedly along. In the more open parts I often saw several pairs of Ground Hornbills, and each time one had a blue throat, the other a red one. I can but think that this is a sexual character, though which is the female and which is the male I was unable to determine. Other birds seen were *Pœocephalus meyeri*, a species of *Macronyx*, *Irrisor erythrorhynchus*, *Hirundo rustica*, and the handsome Snipe *Rhynchæa capensis*.

A very amusing bird that I watched was *Erythropygia ruficauda*, which is most assiduous in its courting of the female, spreading its tail before her like a fan.

In the more shady parts one might often see the butterflies, as I remember seeing them in the forests of Paraguay, covering the ground with large patches of colour, in flocks according to their species.

Shortly before reaching Hoima the river Kafu is crossed; here a network of papyrus-swamps with good causeways over them abound in duck, geese, and kingfishers of various kinds. Then, winding upwards, a high point is reached from which the village of Hoima is seen, and in the very far distance one can make out the Blue Mountains on the other side of Lake Albert. At this high point I saw a charming little Widow-bird (*Vidua hypocherina*). Lions round this part are plentiful and somewhat dangerous, as they usually are in countries where game is not abundant. At Hoima I heard that several natives had recently been carried off by the Lions.

From here, two days' march through the so-called Budonga Forest brings one to the shores of Lake Albert. This Budonga Forest is nothing more than rather heavily-wooded scrub. It is true that in the ravines and gorges there are strips of real forest, but it is not in any way comparable with the real forest of the tropics, where the sky can scarcely be seen.

This Budonga woodland teems with herds of Elephant—I myself calculated that there were over 200 in one herd which we came across. Some of the males had enormous tusks, and these big fellows seem to keep slightly aloof from the rest of the herd. I knew that we were quite close to this herd, as there were great roadways through the jungle with quite fresh, smoking dung; and here I first noticed what struck me many times subsequently, that when elephant-dung falls on a pathway or clearing, there within half an hour you will constantly find, heaped up all round the dung, the earth-workings of a shrew or mole. What is it the shrew seeks in the dung? Is it the fly-larvæ that have been blown upon the dung, or is it the dung itself? Frequently elephants in these parts appear of a bright red colour, having covered their bodies with the dust of crushed-up termite hills.

On July 29th I looked from a high point on the road on to Lake Albert, a vast sheet of glistening water, 1000 feet below, bordered on this side with level plains of park-land, broken here and there by lagoons and swamps, where I was to try first for the *Polypterus*.

Of the results of my *Polypterus* work during this journey I shall say nothing here; suffice it that I stayed down by the lake-side from July 30th to August 15th, trapping, netting, and shooting. During this time the fishes most abundantly met with were *Hydrocyon forskalii*, *Alestes baremose*, *Distichodus niloticus*, *Labeo hosei*, *Bagrus bayad*, *Eutropius niloticus*, *Synodontis nigritus*, *Tilapia nilotica*, also very large specimens of a *Citharinus*.

Lates niloticus is frequently caught by the natives here 5 and 6 feet long, usually with the spear. *Protopterus* and *Polypterus* were both obtained here. The River-Tortoise (*Trionyx triunguis*), 28 inches in length, and very large specimens of *Rana occipitalis* were also common here.

The common Antelopes were *Cobus thomasi*, *Cobus defassa*, *Tragelaphus scriptus*, Oribi, and *Cephalophus æquatorialis*. Down on these lake-side flats the avifauna differs in a marked manner from that in the highlands. *Hyphantornis cucullatus* was now building in hundreds in the water-side bushes; *Laniarius barbarus* and *Telephonus senegalus* in the low bushes, with *Merops albicollis*, *Lamprocolius purpureus*, *Pyromelana flammiceps*, *Terpsiphone perspicillata*, and *Dicrurus assimilis*, were the birds most frequently met with. These birds were seldom seen in the highlands.

Lanius excubitorius seems to have a curious habit of giving a peculiar chattering call whenever a wounded animal is near. We often made use of this indication when tracking wounded beasts, and I have no doubt of the truth of this fact.

From here I struck due east through the Budonga Forest again to the Victoria Nile. The journey through this woodland country was at this time of year most arduous, all the paths being densely overgrown with rank grass, while in the ravines the creepers and hanging lianas were a great hindrance to the porters. During the four days I was in this rank jungle I saw very little in the way of animal-life except Elephants, a few Baboons, and an occasional Puff-Adder, one of them 4 ft. 5 in. in length, and a few interesting insects—Phasmidæ and Mantidæ.

Plant-life was much more interesting, and almost overwhelming with its abundance of variety and its beauty.

The handsome Nightjar (*Cosmetornis vexillarius*) was often seen at sunset in these forest-camps.

At length we struck the old road from Masindi to Wadelai, and the bicycle came into use again. At my first camp along this road there were large numbers of a golden-eyed black Weaver-bird (*Ploceus nigerrimus*), which I saw nowhere else. In its size and shape, courting- and nesting-habits, it resembles very closely the gregarious *Hyphantornis cucullatus*.

The Masindi road now made straight for a high conical hill, from the shoulder of which we had this part of Africa laid out as a map before us. To the south, the Budonga Forest; to the west, the north end of Lake Albert, with the valley of the White Nile extending northwards; and immediately below, from east to west, the valley of the Victoria Nile. Descending from terrace to terrace, we at length arrived at the village of Fajao, just below the Murchison Falls, on the 22nd of August.

This wonderful gorge has been described by Baker, Vandeleur, and others, and their descriptions are no exaggeration. One looks down on the swirling, surging water, that, leaving the base of the falls, sweeps round the hill on which the old fort used to stand, with a feeling of utter amazement at the vast numbers of leaping fishes, crocodiles, and hippopotami that have found their way into this *cul-de-sac* of the Nile system.

Here I continued my work with more success than on Lake Albert, the commonest fishes being *Alestes baremose*, *A. macrolepidotus*, *Lates niloticus*, *Clarias lazera*, *Tilapia ziblii*.

The natives here use enormous wattle-traps, which they set in certain fixed spots, usually out of the main force of the current, and often catch very large fish in them.

On August 29th I started again, as this is a most unhealthy place; many of my men were on the sick-list, and food was getting scarce.

Once out of the gorge of the Victoria Nile, we came into open rolling savannah country of grass and Borassus-palms, baobabs, and scrubby acacias. Then crossing several rivers with difficulty, we arrived at Wadelai on September 1st.

During this stage of the journey I noticed several birds not seen in this part of Africa before: there was *Corvinella affinis*, *Parus leucopterus*, and several species of Capitonidæ, all reminding me, as did the landscape, of the Gambia on the West Coast. Here also were *Melittophagus bullockoides*, *Macronyx croceus*, *Urolestes æquatorialis*, *Telephonus* and *Crateropus*.

From Wadelai I sent my porters on to Nimule, about 100 miles distant, taking my loads and servants down the river by boat.

After a few days' work at Wadelai, we started down the river on the 8th of September. The scenery on this part of the Nile is very charming, the hills in many places coming right down to the water's edge. Here one sees the process of the growth of the *sud* in every stage. Beginning with the floating separate plants of *Pistia stratiotes*, the seeds of, first a small floating rush, then of the "*oom soof*" grass, settle on and gradually bind together this carpet of separate plants into a floating island of grass. So abundant are these floating islands that often we appeared to be stationary, even when moving at 5 or 6 miles an hour, for all the visible banks were moving too. Once, however, the mass lodges against the stationary papyrus, it quickly becomes overgrown by this, and is converted into permanent *sud*.

Fishing villages are numerous on this part of the Nile. The

natives make very good traps of papyrus-grass, and also hunt the hippopotamus with long spears with a rope and float of ambatch-wood attached. Amongst other fishes caught here were *Mormyrops*, *Mormyrus*, *Hyperopisus*, and *Malapterurus*.

Much of this way the hills retreat, and there is nothing seen but grass floating and grass stationary, not even bird-life to relieve the monotony. The last 20 miles, however, before reaching the garrison town of Nimule it is very different. The Nile flows straight towards the mountains above Nimule, and here widens into beautiful lagoons covered with water-lilies, in the foreground sheets of *Pistia* of the most vivid green, in the background bold wooded hills. Here and there are rocky islands with schools of hippopotami basking in the sun; Bee-eaters (*Melittophagus pusillus*), the Jacana (*Parra africana*), and the gorgeous little Kingfishers (*Corythornis cyanostygma*) abound. And then the Nile plunges into the great Nimule gorge, to tumble down cataract after cataract, breaking up and pulverizing the floating vegetation, and issuing again at Fort Berkley free from *sud*.

I was now getting anxious about catching the Sudan Government steamer, which comes up once a month to Gondokoro, and determined to leave the Nile and go straight overland for Gondokoro. The actual distance was little over 100 miles, but at this time of year the difficulties of travelling and crossing over rivers in flood were such that one could not tell at all how long the journey would take. After passing through the Nimule gorge, we came to the affluence of the Assua with the Nile. The Assua was now in flood, the only way of crossing being by means of small rafts of ambatch-wood equal to taking one load at a time. None of my porters were able to swim, and all had likewise to be crossed on the rafts. After very nearly losing two men down the rapids, the crossing was completed after eleven hours' hard work. Here, again, the bird-life was different. I saw many birds while on the march that I was unable to identify. There were great numbers of a Weaver-bird of brownish colour with a white crown, building innumerable star-like nests made of straight wiry grasses woven in at a tangent to the nest. There were also seen in these parts, for the first time, *Scoptelus notatus* and *Cryptorhina afra*, though amongst these were not seen specimens with red beaks as was the case on the Gambia.

Just below its confluence with the Assua River the Nile flows on two sides of a high hill; a fact which strikes one as remarkable, for the two branches were mountain-torrents of very little depth of water.

There we left the river, and passed through country with many villages and a good deal of cultivation, especially ground-nuts and millet. The aspect of this country of the Madis struck me as remarkably similar to that of the Gambia: the soil was rich and sandy, and the nuts produced were of great size. In some of the valleys we saw quantities of very fine bamboo, while many of the trees were almost smothered by the beautiful creeping lily *Gloriosa superba*.

In one of these villages quite 10 per cent. of the natives had marked elephantiasis. They were very friendly, and provided me with whatever I wanted. After three days' wandering by winding paths from village to village, we came back to the main path by the side of the Nile, which for over sixty miles runs along close under a range of mountains on its western bank. From this point northwards for some time the beautiful little Parrot *Palæornis docilis* was common. The only Antelopes seen in this part of the journey were *Cobus leucotis* and a species of *Damaliscus*. The grass seemed to get longer and longer, and marching in the early morning, when the heavy dew was hanging from every blade of grass in great drops, was most disagreeable.

On September 19th we reached the flourishing village of a well-known chief named Adimadi. This village was situated in a hollow on the top of a high hill, with natural rocky fortifications surrounding it, and overlooking a fertile valley to the east. On the heights above the village I saw considerable numbers of what appeared to be a large red *Colobus*-monkey, a specimen of which I failed to secure.

Long-horned cattle were plentiful here, and are probably the same race as the long-horned cattle of Ankoli.

On the hill-sides were numbers of very fine African mahogany-trees (*Kaia*) and springs of good water. In these trees were many kinds of Plantain-eaters and Rollers (*Coracias caudatus*). This was the first place during the whole journey that I met with any Rollers. The hitherto daily rainstorms were getting less frequent, and the dry-season was setting in.

From here we marched through undulating park-like country with small trees, to a similar isolated group of hills, with the village of Leju nestling beneath. Here, again, were fine spreading trees, in which were numbers of beautiful glossy Starlings (*Spreo superbus*), and also the King of the Sparrows (*Dinemelia dinemelia*). Passing down from the Leju hills again, we marched through country of a rather barren nature, of rank grass and small acacias. The whole way the elephant-tracks were very numerous, and we came suddenly on a herd of twelve with two old tuskers among them.

The country now became more and more barren, and on September 22nd we reached the hills again, opposite the Belgian station of Redjaf. Here I saw several birds I had not seen before, including *Merops nubicus*, *Vinago waalia*, *Laniarius erythrogaster*, and, I think, *Lanius collurio*, though it may have been a different species.

At Gondokoro I sent back all my porters and Uganda servants, and after a few days' work fishing &c., I started northwards, on the Sudan Government steamer 'Abuklea,' for Khartoum, on September 27th.

The first few days the steamer passes through firm banks, on which, notwithstanding the grass, we saw several water-buck and some buffalo. Many small villages line the banks, while several old Dervish forts are passed.

At Canissa, about 100 miles north of Gondokoro, I changed into the 'Kaibar,' the post-boat to Khartoum; then, passing through the *sud* region in three days, we came to the mouth of the Sobat and the land of the Shelluks.

On my arival at Khartoum, I set to work to get Arab fishermen and servants, fishing-tackle, provisions, &c., and returned in a few days to Fashoda.

Here I made my final attack on the *Polypterus* problem. I had three species of *Polypterus* to work with, while material was fairly abundant. However, after several weeks' work, I finally packed up my things, and disconsolately returned to England; having got a good deal of side-light on the life and habits of *Polypterus*, having seen something of the Fauna and Flora of the most wonderful river in the world, but having again failed in my principal object—namely, to obtain the early stages in the development of *Polypterus*.

In conclusion, I should like to say that, throughout the journey, I received at the hands of the Uganda and Sudan officials the most courteous and liberal assistance on all occasions.

The following papers were read:—

1. Note on the Spiracles of *Polypterus*.

By J. S. Budgett, M.A., F.Z.S.

[Received January 19, 1903.]

On seeing a letter in 'The Field' for November 8th, 1902, by Mr. Boulenger, in which he says that, after observing *Polypterus* in captivity for more than a year, he had not been able to learn anything concerning the use of the spiracles to *Polypterus*, I determined to go over my former observations concerning these structures and see whether I had by chance been mistaken as to their use.

I have in captivity a pair of *Polypterus senegalus* kept in an aquarium at a temperature of 75° to 80° F. They are quite tame and regularly take food from a fork.

On December 2nd I watched them for one hour after feeding. While eating, the spiracles were repeatedly rapidly opened and closed, though not widely. The movement was apparently independent of other masticatory movements. Within the hour each of the pair came to the surface three times at irregular intervals.

1. Specimen A came to the surface and gulped air with the mouth; immediately after leaving the surface, two large bubbles of air were discharged from under the opercula. During the descent to the bottom the two spiracles slightly opened and from each a minute bubble of air issued.
2. Specimen B performed the same movement, but no air was seen to issue from the spiracles.

3. Specimen B repeated the movement, and small bubbles of air did issue from the spiracles.
4. Specimen A repeated the movement, but no air was seen to issue from the spiracles.
5. Specimen B repeated the movement violently after some excitement, and as it met the surface *widely opened* the spiracles, forming a triangular aperture, one side being the side of the head and the two other sides being the two plates of bone which form the spiracular flap; whether air passed in or out of the spiracles was impossible to see as the top of the head was out of the water. No bubbles passed from the spiracle during descent.
6. Specimen A repeated the movement, the spiracles did not open, and no air was seen to issue from them during descent.

On December 8th I watched them again for an hour. *Polypterus* A and B came to the surface for air 8 times, and 4 times the spiracles were *widely opened* above the surface of the water, and a sound produced as of the sucking in of air.

I have often found it convenient to kill *Polypterus* by piercing the cranial roof and destroying the brain. During the operation it is quite easy to stimulate the brain-centres in such a way that the spiracles are widely opened as described above. It is possible to stimulate continuously so that the spiracles are retained in the widely opened condition. I believe, then, that the spiracles are used to take in and to give out air from the swim-bladder. At certain times the fish rises quite slowly to the surface in the horizontal position, when it would be easier for it to exchange the air in the swim-bladder from the surface of the head than to turn its head upwards in order to take air by the mouth. By closing the mouth and opercula, distending the body-wall and opening the spiracles, I believe the fish is able to inhale air, and I should suppose that it expires previously during the same movement, as does *Protopterus*. I think it possible also that in the very shallow water which this fish frequents at certain times of year, it may be of use to the fish to change the air in its swim-bladder in this way. I have often noticed, in changing the water in a tank in which numbers of these fish are confined, that when the water is exhausted the spiracles are frequently opened.

The position of the spiracles almost immediately over the long slit-like glottis is in favour of the view that they are connected in their functions with the latter. They seem also to be used, as I at first believed, to let out the excess of air from the pharynx after the fish has taken air into the swim-bladder, either with the mouth or with the spiracles.

Observation upon these points is very difficult owing to the rapidity with which the movement takes place; but the fish I have been watching have become very tame, after three years of captivity, and these movements are now more slow and much more easily watched.

2. On the Brains of *Nasalis larvatus* and of some other Old World Primates. By Frank E. Beddard, F.R.S. &c.

[Received January 17, 1903.]

(Text-figures 2–8.)

Among the types of Old World Primates not studied by Messrs. Kükenthal and Ziehen [1] in their otherwise fairly exhaustive survey of the cerebral convolutions in the Apes, are *Nasalis* (if it be a distinct genus), *Colobus*, and *Cynopithecus*. I take the opportunity afforded me by the possession of brains of these three genera to compare their characters with those of other Old World genera. The memoir of Kükenthal and Ziehen has aided me greatly in this attempt on account of the clearness and accuracy of their figures, many of which I have been able to verify by an inspection of brains of the same or allied species. I do not, however, always find myself able to agree with the selection of characters which they use to define the various genera of Apes examined by them [2]. I cannot distinguish by any tangible differences the arrangement of the furrows in the genera *Macacus*, *Cercopithecus*, *Cercocebus*, and perhaps *Papio*. It appears to me, in fact, that among the Cercopithecidæ there are only two plans of cerebral conformation, one confined to the Cercopithecinæ and the other to the Semnopithecinæ. The facts which I discuss in the present communication are confirmatory of that view. But the classificatory results to which they appear to lead are not a little surprising, and may possibly be regarded as tending to throw doubt upon the use of the cerebral convolutions as an index of anything save physiological resemblances.

§. *The Brain of* Nasalis larvatus.

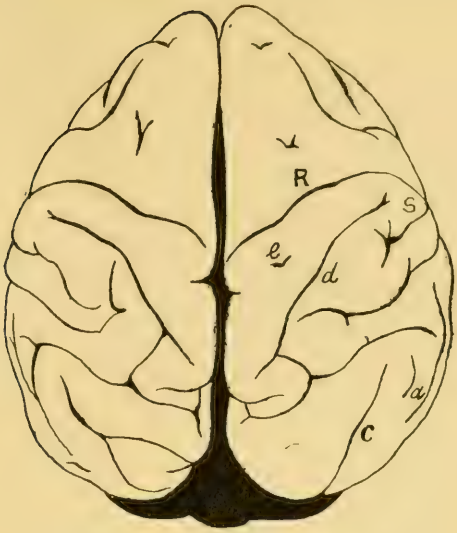
I have been able to compare the brain of the young male *Nasalis larvatus* [3] with those of two other examples, which I owe to the kindness of Dr. Charles Hose of Borneo, and I find that there are, as might be expected, some slight differences of detail in the arrangement of the furrows. The accompanying drawing (text-fig. 2) illustrates the superior aspect of the cerebral hemispheres of the specimen of *Nasalis* which forms the subject

[1] "Untersuchungen über die Grosshirnfurchen der Primaten," Jen. Zeitschr. f. Naturw. xxix. (n. s.) 1895, pp. 1–122.

[2] For instance, I find that the backward prolongation of the sulcus præcentralis, whose absence is stated as a characteristic of *Cercopithecus*, is present in *C. stairsi*. In *Cynocephalus mormon* the parallel fissure joins the Sylvian *above*, so that the statement "*a* [the parallel fissure] nähert sich dem hinteren Ende von *S* [the Sylvian] um *S* dann im Bogen zu umkreisen" is not universal in its application. In the same species the furrow hitherto lettered *b* (= inferior occipital) is not "entirely confined to the lateral convexity"; it also extends ventrally. The fissures *u* and *x* form a complete Y-shaped furrow as in other Old World forms. Messrs. Kükenthal and Ziehen write:—"*x* verschmilzt gar nicht oder nur scheinbar mit *u*."

[3] Gratiolet (Mém. sur les Plis cérébraux, &c. pl. iv. figs. 1, 2) has figured a brain of this animal.

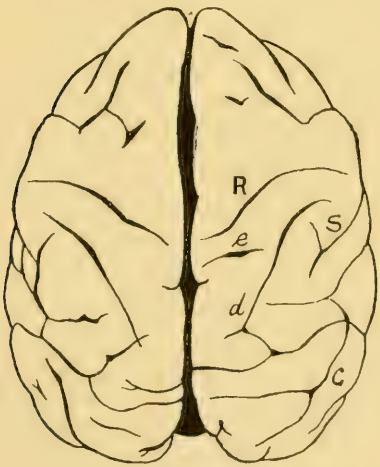
Text-fig. 2.



Upper surface of cerebral hemispheres of *Nasalis*.

a, inferior occipital fissure; *c*, lateral occipital fissure; *d*, intraparietal; *e*, postcentralis; *R*, fissure of Rolando; *S*, Sylvian.

Text-fig. 3.



Another brain of the same species.

Letters as in text-fig. 2.

of the present communication, while the internal view of one hemisphere is shown in another drawing (text-fig. 4, p. 15). The variations that I have noted in the three brains are the following:—

There is some variability in the exposure on the upper surface of the brain of the parieto-occipital fissure. This, as will be seen from the drawing exhibited (text-fig. 2, p. 13), is better marked in a large female brain, given to me by Dr. Hose, than in the smaller male brain (text-fig. 3, p. 13). In the third brain there are only just traces to be observed of this fissure on the superficial view of the brain. A furrow which I identify with the *postcentralis superior* is present here in rudiment (as it is in the Macaques and other genera) occasionally. It is best developed, but practically on one side only (the right), in the small male which lived in the Society's Gardens. In the large female brain there are traces of the fissure on one side only (the right); the fissure is absent in the third brain.

The fissure of Rolando curves back and joins the Sylvian fissure in the large female brain; it does not do so in the two remaining brains. On the left side of one brain the Sylvian and the parallel fissures joined superiorly, a state of affairs which is characteristic of the brains of many monkeys.

On the right hemisphere of one brain only the lateral occipital fissure was incomplete, and consisted of the lower arm only, there being but a faint indication of the upper arm of this **Y**-shaped fissure.

These appear to me to be the principal differences in the sulci of the three brains.

I have compared them carefully with the brains of six species of *Semnopithecus* [1], of which I owe two to the kindness of Dr. Hose, while four were extracted from the skulls of specimens which have lived in the Society's Gardens.

The species are as follows:—*S. maurus*, *S. femoralis*, *S. hypoleucus*, *S. rubicundus*, *S. priamus*, and *S. entellus*. The differences between these brains and those described by Kükenthal and Ziehen [2] are slight.

The fissure lettered *E* by the above-named authors, which is the presylvian of other writers, is less regular in its occurrence than it appears to be in *Nasalis*, but the difference is not sufficiently marked to permit of any stress being laid upon the fact. In only one instance (*S. femoralis*), and on one side only (the right), did the Sylvian fissure join the parallel fissure above. The rarity of this arrangement is exactly as in *Nasalis*. In one case only (*S. maurus*), and also on one side only (the left), were there indications of the fissure of Rolando joining the Sylvian fissure. The rarity of this arrangement is again paralleled in *Nasalis*.

[1] Kükenthal and Ziehen (Jen. Zeitschr. 1895, p. 1) refer to the literature, but they have not included a paper by Lankester (Quart. Journ. Sci. ii. 1865).

[2] "Untersuchungen über die Grosshirnfurchen der Primaten," Jen. Zeitschr. 1895, p. 1.

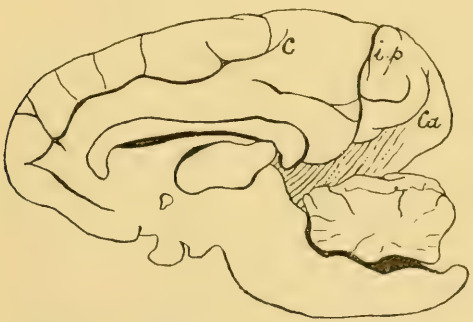
The relations of the parieto-occipital and the Simian fissures appear to me to be exactly the same in *Semnopithecus* as they are in *Nasalis*. As a rule, they are perfectly distinct from each other; but in two brains the operculum was more fully developed, as it is in the Macaques, and thus the two fissures appeared to coincide.

The postcentralis I found to be always present, and on both sides, though often asymmetrical.

In four *Semnopithecus* brains I find a small furrow running between the intraparietal and the Sylvian, which may represent the anterior fork of the parallel fissure figured by Kükenthal and Ziehen in several Apes (and lettered *a'* in their figures), and stated to occasionally occur in *Semnopithecus*. The existence of this fissure, so far as my material allows me to state, differentiates the brain of *Semnopithecus* from that of *Nasalis*.

Dr. Elliot Smith[1] has mentioned in one brain of *Semnopithecus entellus* a bifurcation of the calcarine fissure, such as that which is constant, or nearly so, in *Macacus* and *Cercopithecus*. I have found this well developed on one side (the left) of a brain of *S. rubicundus*, and less marked on the same side of a brain of *S. priamus*, and on the right side of a brain of *S. femoralis*. It may be observed, however, that in *Semnopithecus* the T-shaped calcarine fissure, when it is T-shaped, is not visible on a dorsal view of the undivided brain as it is in *Macacus*. In the largest of the three brains of *Nasalis* which I have examined, there were indications of the same bifurcation on the right side.

Text-fig. 4.



Longitudinal median section of brain of *Nasalis*.

c, calloso-marginal fissure; *Ca*, calcarine; *i.p*, internal parieto-occipital.

The inferior occipital sulcus is always less in the Langurs than in the Macaques. In one *Semnopithecus* brain (the left side of *S. priamus*) this furrow showed an unusual character, in that it joined the parallel fissure. The same occurred on the right

[1] Cat. Physiol. Ser. R. C. S. ed. 2, vol. ii. p. 426.

hemisphere of a brain of *S. hypoleucus*. This I have not seen in *Nasalis*.

This same brain (of *S. priamus*) and a brain of *S. entellus* show on both sides an unusual condition of the inferior temporal fissure, which is well developed and runs parallel with the Sylvian and parallel fissures. The more usual condition in this genus is a much shorter fissure which is more transverse in direction, and that is the condition which obtains in *Nasalis*. The fissure is not figured at all by Kükenthal and Ziehen, but is mentioned as being very feebly developed. Another furrow which I find to vary in the *Semnopithecus* brains at my disposal is the calloso-marginal sulcus; it sometimes bends up and cuts the surface of the brain. In *Nasalis* it always does.

§. *The Brain of* Colobus vellerosus.

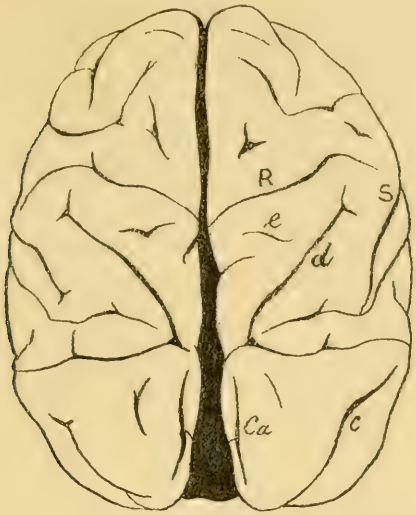
Broadly speaking the brain of this monkey is very like that of a Macaque. There are, however, a few small points of difference, of which one at any rate may be of some little significance. The resemblance is so close in most particulars that it is really unnecessary for me to describe the brain in detail. The drawing exhibited herewith (text-fig. 5, p. 17) will adequately prove my statement. I may, however, remark that the fissure of Rolando quite cuts the inter-hemispheral sulcus: that the post-centralis is well marked on both sides: that the precentralis superior is recognizable and has a direction parallel with the long axis of the brain. On one side (the right) the Sylvian and parallel fissures join above, as is so common on both sides with the Macaques. The occipital lobe is very smooth, as is often the case with the Macaques, and the lateral occipital sulcus is hardly marked at all. The cross-piece of the characteristically Macacine calcarine fissure is visible when the brain is inspected from above. A small fissure, which I have not observed in other Old World Monkeys, is to be seen on either side, behind the Simian fissure, and running parallel with the longitudinal axis of the brain. Kükenthal and Ziehen figure, but give no name to an apparently similar fissure (lettered *B*) in the brain of *Lagothrix humboldti*. I am able to confirm their demonstration of fact. They do not figure the same fissure in any of the Cercopithecidæ.

I am unwilling to seem to emphasize too strongly this point of likeness between the African *Colobus* and the New World *Lagothrix*; but I may remind zoologists that likenesses between *Colobus* and the New World Monkeys have been pointed out.

More important than this, however, is the light which the brain-structure of *Colobus* appears to throw upon its relationship to other Old World genera. On account of the structure of its stomach, and for some other reasons also, *Colobus* has been associated with *Semnopithecus* into a subfamily Semnopithecinæ, contrasted with the Cercopithecinæ which embraces the remaining Cercopithecidæ. It should be plain from the statements made in

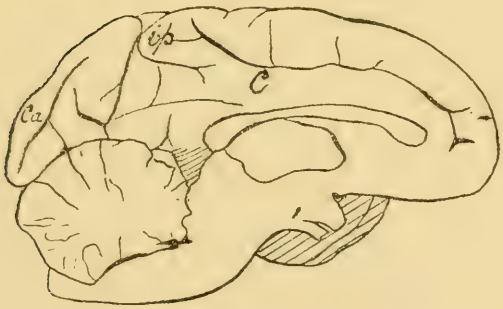
the present paper, and from the illustrations which support them, that so far as its brain is concerned *Colobus* cannot be placed in close proximity to *Semnopithecus*. From this point of view,

Text-fig. 5.



Upper surface of cerebral hemispheres of *Colobus guereza*.
Ca, calcarine fissure. Other letters as in text-fig. 2.

Text-fig. 6.



Longitudinal median section of brain of *Colobus guereza*.
Letters as in text-fig. 4.

Colobus is most emphatically to be placed among the Cercopithecinæ. In fact, it is probably safer to follow those zoologists who do not subdivide the family Cercopithecidæ at all.

§. *The Brain of* Cynopithecus niger.

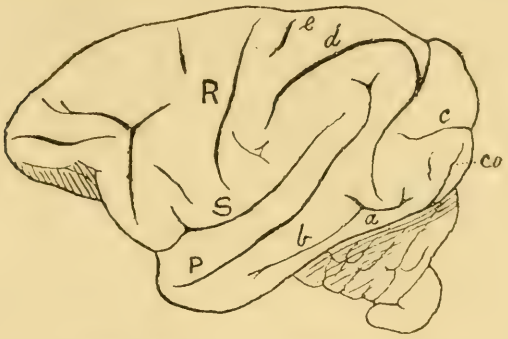
I have been able to examine a single brain of the Celebesian Ape, of which drawings are exhibited herewith (text-figs. 7, 8, p. 19).

The Simian fissure runs completely across and contributes to a perfect operculum, as in the Macaques. But the brain of *Cynopithecus* differs from the brains of the latter and agrees with that of *Semnopithecus* in the fact that the infraparietal fissure of each side bends sharply outwards before joining the Simian fissure; this suggests an exposure of the parieto-occipital, and a very faint groove (better marked upon the left side) is probably to be looked upon as a representative of this. The lateral occipital sulcus is a single fissure, that is to say, it has not the **Y**-shape exhibited in so many monkeys. There is, however, a faint depression suggesting the upper arm of this **Y**. The inferior occipital sulcus is in some respects rather peculiar. Dr. Elliot Smith has justly pointed out [1] that in *Semnopithecus* "the inferior occipital sulcus has dwindled to most insignificant proportions, and unless the student examines a large series of brains he will hardly recognize in the little arc around the lower end of the Simian sulcus the representative of the deep operculated infra-occipital sulcus in the Macaques." *Cynopithecus niger* has an even smaller semicircular representative of this furrow, which just arches round the lateral termination of the Simian fissure, and is nowhere near to reaching the posterior extremity of the occipital lobe. Further than this, a straight furrow, either connected (left side) or nearly connected (right side) with this, runs down the temporal lobe for some distance, exactly parallel with and between the parallel and collateral sulci. This I take to be the inferior temporal sulcus of brain anatomists. In the Macaques and *Cercopitheci* this sulcus is (so far as my own experience goes) quite constantly represented by a short furrow at the lower end of the temporal lobe, and this furrow is a marked character of those brains, and of *Cercocebus* and *Cynocephalus*. This more ventrally placed furrow is not to be seen in my specimen of *Cynopithecus*. The existence of an upper portion of the inferior temporal sulcus is not, however, absolutely distinctive of *Cynopithecus*. It is indicated in a brain of *Cynocephalus mormon* which I have at my disposal, and in *Nasalis* and *Semnopithecus*. In a brain of *Cynocephalus porcarius* this furrow is as well developed as in *Cynopithecus*, but on one side only (the right). But, with this exception, the furrow is nowhere so fully developed as in *Cynopithecus*. So far, therefore, it appears to be characteristic of this genus. It is, however, apparently impossible to lay much stress upon the reduced inferior occipital sulcus of *Cynopithecus* as a point of resemblance to *Semnopithecus* in the absence of a large series of brains of the former genus. Messrs. Kükenthal and Ziehen figure a brain of *Cynocephalus sphinx* in which the fissure is fully as reduced as it is in *Cynopithecus* or *Semnopithecus*. I have already pointed out (*supra*, p. 12 foot-

[1] Cat. Phys. Series Mus. Roy. Coll. Surg. vol. ii. p. 426.

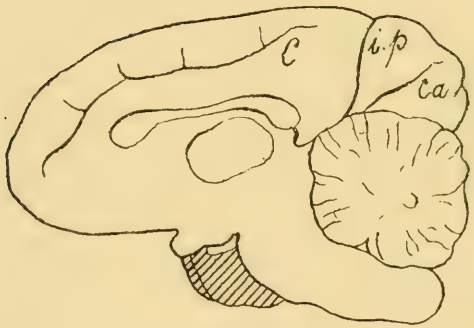
note) that this state of affairs is not universal in *Cynocephalus*; but it has still got to be proved that it *is* universal in *Cynopithecus*.

Text-fig. 7.



Lateral view of brain of *Cynopithecus niger*.
b, inferior temporal fissure; *co*, collateral; *P*, parallel.
Other letters as in text-figs. 2, 3.

Text-fig. 8.



Longitudinal median section of brain of *Cynopithecus niger*.
Letters as in text-fig. 4.

The *collateral sulcus*, as compared with that of the Macaques and *Cercopitheci*, is particularly well developed. It has, so to speak, taken advantage of the feeble development of the inferior occipital to thrust itself forward upon the occipital lobe, where it is plainly visible when the brain is viewed from behind; it is also visible where it curves upwards upon the lateral aspect. It is the rule among Monkeys for this fissure to be largely concealed by the cerebellum. Its exposure for its whole length in *Cynopithecus* appears to me to be a characteristic feature of the brain of that monkey.

The *parallel sulcus* extends considerably beyond the Sylvian fissure, and does not—as is so commonly the case with the Macaques—join that fissure dorsally. An interesting fact about this fissure is that it bends forward at its dorsal extremity, instead of being continued on in a straight line. In this bending I see a point of likeness to the *Semnopitheci* (including *Nasalis*). No absolute distinction between *Cynopithecus* and *Macacus* can be, however, drawn on account of this furrow, since Kükenthal and Ziehen figure a brain of *Macacus inuus* in which there is this same bending forwards, and, moreover, a bifurcation of the furrow superiorly, such as I note in my example of *Cynopithecus niger*. The *fissure of Rolando* presents no noteworthy characters; it does not nearly cut the inter-cerebral groove. The *postcentralis* is better developed on the right side of the brain than on the left, and is transverse in both cases. The *precentralis superior* is, on the other hand, better developed upon the left side than upon the right. It is transverse in position. Among Monkeys this fissure is more commonly parallel with the long axis of the brain.

The *median parieto-occipital sulcus*, visible when the brain is bisected longitudinally, presents what I regard as rather an interesting and suggestive character. This fissure, in the Macaques, &c., has a distinctly forward inclination, often making an angle of quite 45° with the vertical. On the other hand, in the *Semnopitheci* this furrow is nearly vertical (a brain of *Nasalis*) or with a distinctly backward inclination. In *Cynopithecus niger* this same furrow is nearly vertical, but with a slightly backward inclination, thus resembling the Semnopithecidæ more than the Cercopithecidæ.

The *calcarine sulcus* of *Cynopithecus* is not at all like that furrow in the brains of *Cynocephalus*, *Macacus*, *Cercopithecus*, and *Cercocebus*. In the four last-named genera it is a T-shaped sulcus, the cross of the T appearing almost, sometimes in fact quite, upon the upper surface of the occipital lobe. This furrow is very characteristic of those genera. In *Cynopithecus* the furrow is simple and oblique in direction, as it is, as a general rule, among the Semnopithecidæ.

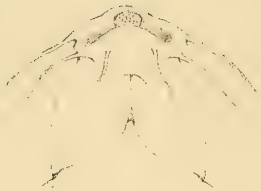
It may be convenient to tabulate the likenesses shown in the brain of *Cynopithecus* to that of *Semnopithecus*.

The brain resembles that of the *Semnopitheci* in:—

(1) The form of the intraparietal fissure.
(2) The backward direction of the internal parieto-occipital.
(3) The absence of any junction between the Sylvian and parallel fissures.
(4) The simple form of the calcarine fissure.
(5) The shortness of the inferior occipital fissure.
(6) The presence of a well-marked superior portion, and the absence of an inferior portion of the inferior temporal fissure.

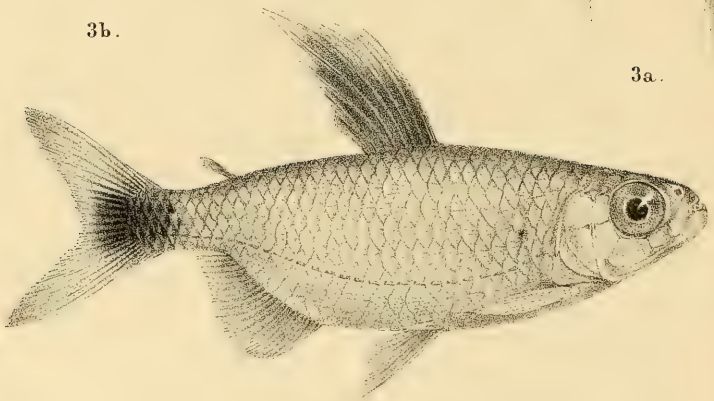
The first two characters are absolutely distinctive of *Cyno-*

3.

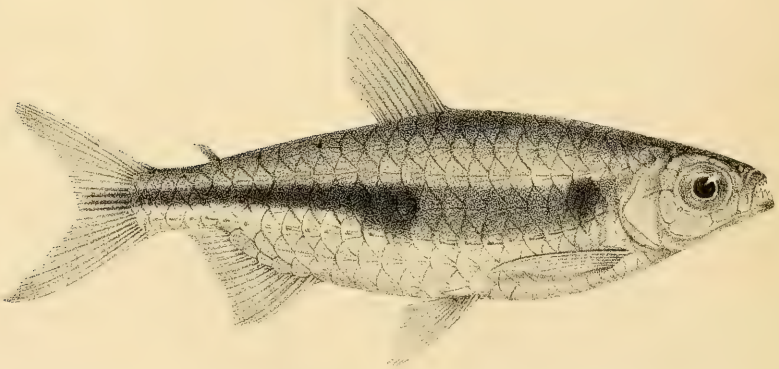


3b.

3a.



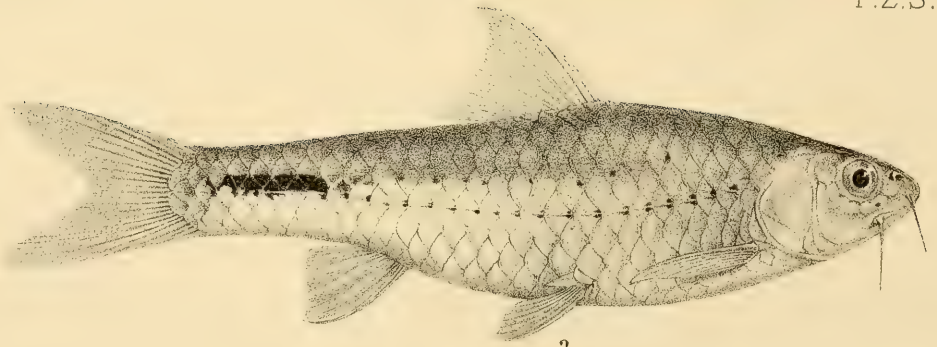
1.



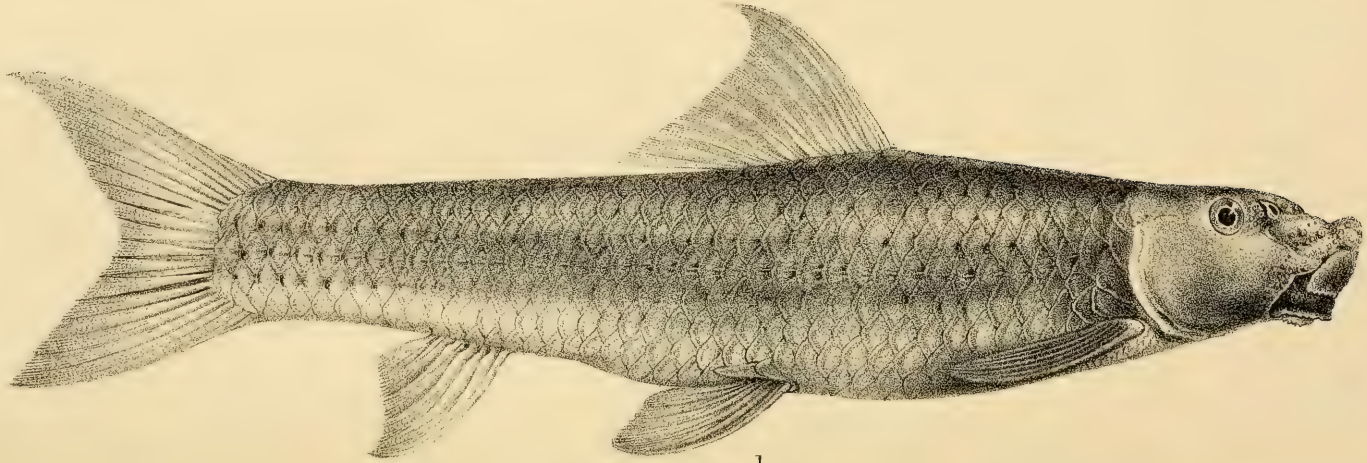
2.

J.Green del.et lith. Mintern Bros. imp.

1. ALESTES INTERMEDIUS. 2. ALESTES OPISTHOTÆNIA.
3. AMPHILIUS LONGIROSTRIS.



2.

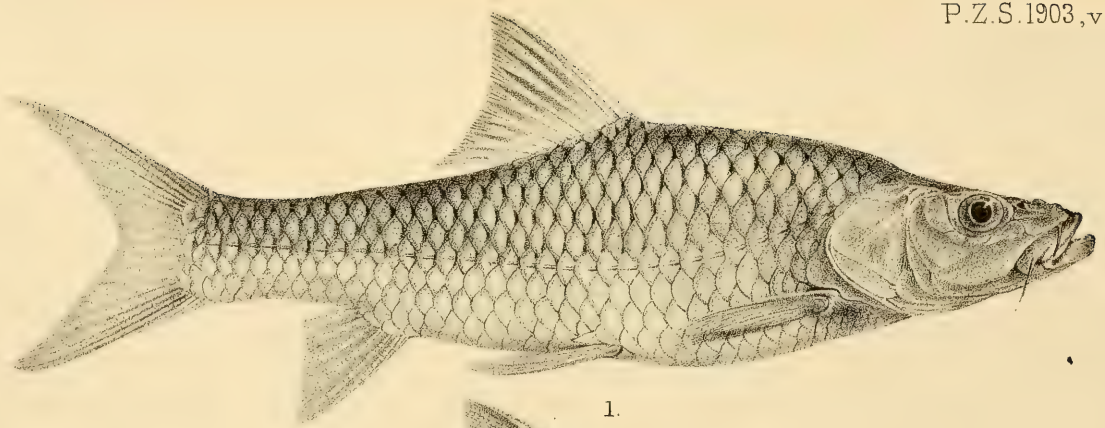


1.

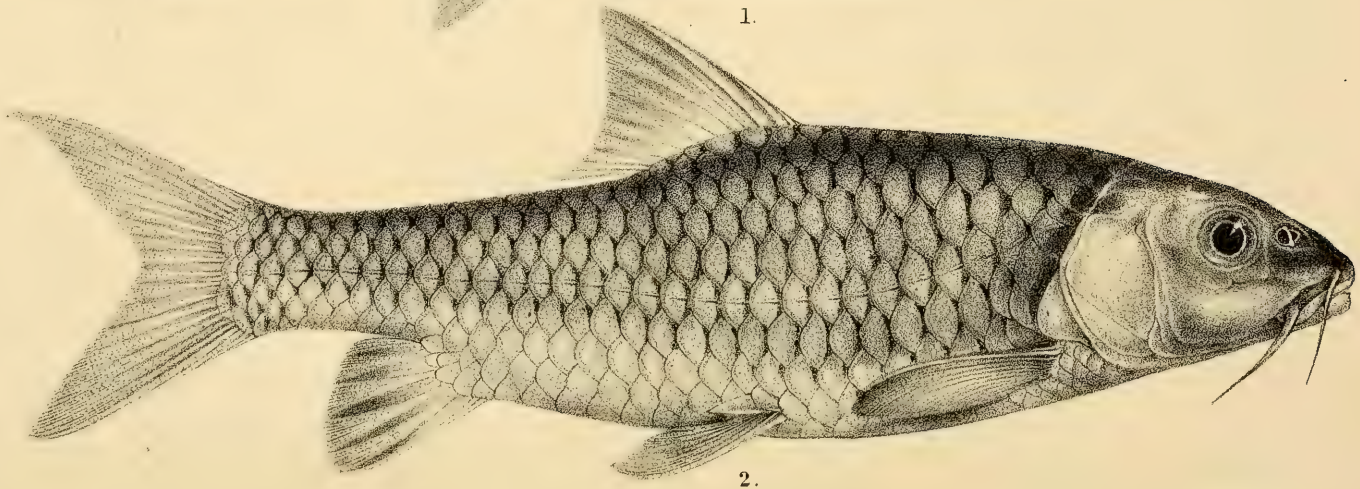
J.Green del.et lith.

1.LABEO ANNECTENS. 2.BARBUS TÆNIURUS.

Mintern Bros.imp.



1.



2.

J.Green del.et lith.

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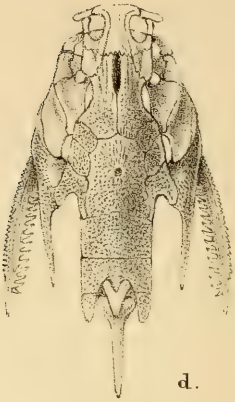
1. BARBUS PROGENYS. 2. BARBUS BATESII.

b.

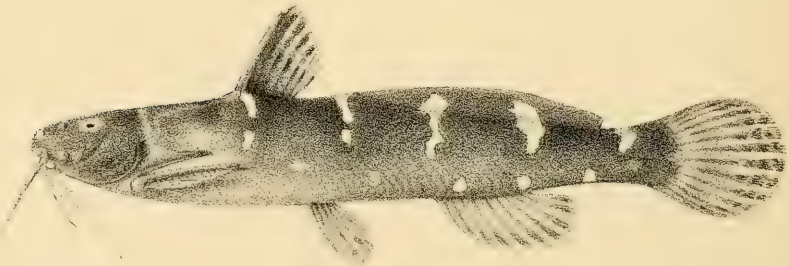


d.

e.

f.

c.

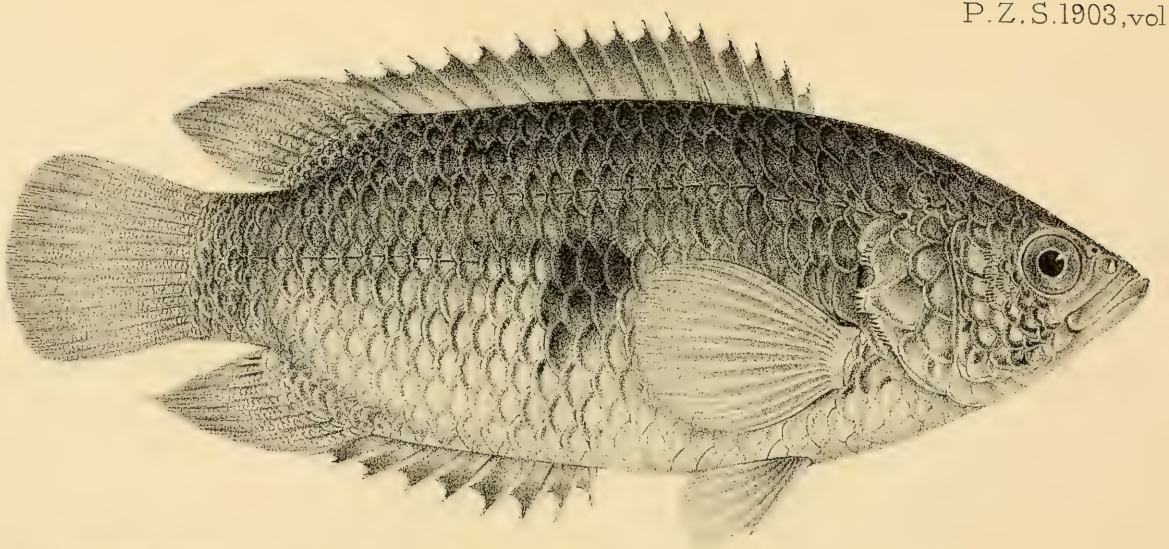


a.

J.Green del. et lith.

Mintern Bros. imp.

MICROSYNODONTIS BATESII.



1.

2.

J.Green del.et lith.

Mintern Bros. imp.

1. ANABAS PLEUROSTIGMA. 2. MASTACEMBELUS SCLATERI.

pithecus and *Semnopithecus*; the third and fourth very nearly so, the last two characters are found also in *Cynocephalus*, but are more characteristic of *Cynopithecus* and *Semnopithecus*.

It will be seen that if one were permitted to base a classification upon cerebral characters, *Cynopithecus* would have to be removed from its position among the Baboons and placed nearer to the Langurs; this is not too extreme an interpretation of the brain-characters considered on purely morphological grounds. We may possibly regard *Cynopithecus* as occupying a somewhat basal position with regard to *Cynocephalus* on the one hand, and *Semnopithecus* on the other. For, in fact, its characters occur in both, though the Baboon-like characters are on the whole less marked.

3. On the Fishes collected by Mr. G. L. Bates in Southern Cameroon. By G. A. Boulenger, F.R.S., V.P.Z.S.

[Received November 28, 1902.]

(Plates I.–V.)

The freshwater fish-fauna of Cameroon is still very imperfectly known. A small list published by Peters in 1876 [1] and another by Lönnberg in 1895 [2] are the only contributions that have hitherto appeared on this subject. The collection made by Buchholz and reported upon by Peters was important as yielding the first specimen of the curious *Pantodon buchholzi*, since rediscovered in the Niger Delta and in the Upper Congo and Ubangi. It has now been ascertained that this little fish flies or darts through the air, and is, in fact, a freshwater flying-fish. Dr. Pellegrin, of the Paris Museum, has kindly informed me that, according to the notes of M. J. de Brazza, the specimen obtained in the Congo by this explorer was caught by means of a butterfly-net whilst moving like a dragonfly above the surface of the water.

Mr. G. L. Bates, whose previous collections included some very remarkable Batrachians described in these Proceedings, has now made, at my request, a rather extensive collection of freshwater fishes in Cameroon, of which I here give a list, together with descriptions of nine new species, one of which deserves to be made the type of a new genus.

The specimens were obtained mostly in the Kribi River, some 15 miles from the sea; others are from a small tributary of the Campo River, near Efulen, Bulu Country, 1500–2000 feet; whilst others again are from the Mvile River, a small stream flowing southwards into the Campo, at about the same altitude as the preceding.

[1] Mon. Berl. Acad. 1876, pp. 195 & 244.
[2] Œfvers. Vetensk.-Ak. Förh. Stockholm, 1895, p. 179.

MORMYRIDÆ.

1. PETROCEPHALUS SIMUS Sauv.

2. ISICHTHYS HENRYI Gill.

3. MARCUSENIUS SPHECODES Sauv.

4. MARCUSENIUS BRACHYHISTIUS Gill.

CHARACINIDÆ.

5. BRYCONÆTHIOPS MICROSTOMA Gthr.

6. ALESTES LONGIPINNIS Gthr.

7. ALESTES INTERMEDIUS, sp. n. (Plate I. fig. 1.)

Depth of body 3 times in total length, length of head 4 times. Head as long as deep, twice as long as broad; snout shorter than diameter of eye; latter $2\frac{2}{3}$ to $2\frac{3}{4}$ times in length of head; adipose eyelid indistinct; interorbital width $\frac{1}{3}$ length of head; width of mouth equal to diameter of eye; maxillary not extending quite to below anterior border of eye; 14 teeth $(\frac{6}{8})$ in the upper jaw, 8 in the outer row of the lower jaw; length of lower border of second suborbital less than diameter of eye. Gill-rakers moderately elongate, 12 or 13 on lower part of anterior arch. Dorsal II 8, above ventrals, originating a little nearer end of snout than caudal, middle branched rays much produced ($1\frac{1}{2}$ to $1\frac{2}{3}$ as long as head) in the males. Adipose fin small, $1\frac{1}{2}$ to twice as distant from the rayed dorsal as from the caudal. Anal III 19–21, the outline very convex in the males. Pectoral shorter than head, not reaching ventral; latter produced into a long filament in the males. Caudal forked. Caudal peduncle a little longer than deep. Scales 33–34 $\frac{6\frac{1}{2}}{3\frac{1}{2}}$, 2 between lateral line and ventral. Silvery; a large black spot on the caudal peduncle and on the median rays of the caudal; latter yellow, blackish at the end; dorsal black and red.

Total length 85 millim.

Three specimens from the Kribi River.

Intermediate between *A. longipinnis* Gthr. and *A. tholloni* Pellegr. Differs from the former in the smaller scales, from the latter in the smaller number of anal rays.

8. ALESTES OPISTHOTÆNIA, sp. n. (Plate I. fig. 2.)

Depth of body $3\frac{1}{5}$ or $3\frac{1}{4}$ times in total length, length of head 4 or $4\frac{1}{5}$ times. Head a little longer than deep, twice as long as broad; snout a little shorter than diameter of eye; latter $2\frac{3}{4}$ or 3 times in length of head; adipose eyelid very feebly developed; interorbital width $\frac{2}{7}$ or nearly $\frac{1}{3}$ length of head; width of mouth equal to diameter of eye or a little less; maxillary not extending quite to below anterior border of eye; 16 teeth $(\frac{8}{8})$ in the upper

jaw, 8 in the outer row of the lower jaw; length of lower border of second suborbital equal to diameter of eye. Gill-rakers moderately elongate, closely set, 20 to 23 on lower part of anterior arch. Dorsal II 8, entirely behind base of ventrals, originating a little nearer caudal than end of snout, twice as deep as long. Adipose fin small, $2\frac{1}{2}$ or $2\frac{2}{3}$ times as distant from the rayed dorsal as from the caudal. Anal III 13–15. Pectoral as long as head, reaching ventral or nearly so far. Caudal forked. Caudal peduncle as long as deep. Scales 25 $\frac{4\frac{1}{2}}{3\frac{1}{2}}$, 2 between lateral line and ventral. Silvery, brownish on the back; a black humeral spot and a black lateral band, commencing under the dorsal and extending on the median rays of the caudal; dorsal, caudal, and ventral fins lemon-yellow.

Total length 130 millim.

Four specimens; Kribi River and Mvile River.

Very closely allied to *A. fuchsii* Blgr. and *A. kingsleyæ* Gthr. Distinguished from the former by the less massive form and the longer pectoral fin; from the latter by the more posterior position of the dorsal fin and the larger eye; from both by the more numerous gill-rakers.

9. Alestes macrolepidotus Cuv.

10. Distichodus notospilus Gthr.

11. Xenocharax spilurus Gthr.

Cyprinidæ.

12. Labeo annectens, sp. n. (Plate II. fig. 1.)

Body compressed, its depth nearly equal to length of head, $4\frac{1}{2}$ to 5 times in total length. Head $1\frac{1}{3}$ as long as broad; snout rounded, strongly projecting beyond the mouth, with numerous nuptial tubercles; eye supero-lateral, in the second half of the head, its diameter 5 to 7 times in length of head, $2\frac{1}{3}$ to $3\frac{1}{2}$ times in interocular width; width of mouth, with folded lips, $\frac{1}{2}$ to $\frac{3}{5}$ length of head; rostral flap and posterior border of lip feebly denticulated; inner surface of lip with numerous feeble, transverse plicæ; a small barbel hidden in the folds at the sides of the mouth. Dorsal III 9–10, with strongly notched border; the longest ray equals the length of the head and twice that of the last; the fin equally distant from end of snout and from root of caudal. Anal II 5; longest ray $\frac{2}{3}$ length of head. Pectoral rounded, a little shorter than head, not reaching ventral; latter reaching or nearly reaching vent, its first ray falling under the ninth (sixth branched) ray of the dorsal. Caudal deeply forked, with pointed lobes. Caudal peduncle $1\frac{2}{3}$ as long as deep. Scales 36–$39\frac{4}{7}$, 3 between lateral line and ventral, 12 round caudal peduncle. Olive above, whitish beneath, with a rather indistinct darker lateral band; fins greyish.

Total length 210 millim.

Two specimens from near Efulen.

This new species, allied to *L. parvus* Blgr., is interesting as completely connecting *Labeo* with *Tylognathus*, and showing that the latter genus can no longer be distinguished.

13. Barbus progenys, sp. n. (Plate III. fig. 1.)

Depth of body $3\frac{2}{3}$ times in total length, length of head $3\frac{1}{2}$ times. Snout rounded, depressed, $3\frac{1}{2}$ times in length of head; eye supero-lateral, its diameter equal to the interorbital width and 5 times in length of head; mouth large, its width $3\frac{1}{2}$ times in length of head, lower jaw projecting beyond the upper; lips well-developed, lower interrupted on the chin; barbels two on each side, anterior $\frac{3}{4}$ diameter of eye, posterior as long as eye, the distance between them $\frac{2}{3}$ diameter of eye. Dorsal III 10, last simple ray feeble, not stronger than those following, $\frac{2}{3}$ length of head; free edge of the fin emarginate; its distance from the occiput less than its distance from the caudal. Anal II 5, longest ray $\frac{1}{2}$ length of head. Pectoral $\frac{2}{3}$ length of head, not reaching ventral; latter slightly posterior to origin of dorsal. Caudal peduncle $1\frac{2}{3}$ as long as deep. Scales $33\frac{5\frac{1}{2}}{4\frac{1}{2}}$, $2\frac{1}{2}$ between lateral line and ventral, 12 round caudal peduncle. Silvery, brownish on the back, dorsal and lateral scales brown at the base; dorsal and anal edged with blackish, the former with an ill-defined dark band across the middle; other fins whitish.

Total length 180 millim.

A single specimen from the Kribi River.

Allied to *B. bowkeri* Blgr., from Natal. Distinguished by the more anterior dorsal fin with 10 branched rays, the shorter anal fin, the narrower interorbital region.

14. Barbus tæniurus, sp. n. (Plate II. fig. 2.)

Depth of body $3\frac{1}{3}$ to $3\frac{1}{2}$ times in total length, length of head $3\frac{3}{4}$ to 4 times. Snout rounded, $3\frac{1}{2}$ to 4 times in length of head; diameter of eye 4 times in length of head, interorbital width $2\frac{1}{3}$ to $2\frac{1}{2}$ times; mouth inferior, its width 3 to $3\frac{1}{2}$ times in length of head; lips moderately developed, interrupted on the chin; barbels two on each side, anterior $1\frac{1}{2}$, posterior $1\frac{2}{3}$ to 2 diameters of eye, the distance between them equal to diameter of eye. Dorsal III 8, last simple ray ossified and moderately strong, but much thicker than the first branched ray, a little shorter than head; free edge of the fin emarginate; its distance from the occiput much less than its distance from the caudal. Anal III 5, longest ray $\frac{3}{5}$ to $\frac{2}{3}$ length of head. Pectoral $\frac{3}{4}$ to $\frac{4}{5}$ length of head, not reaching ventral; latter a little posterior to origin of dorsal. Caudal peduncle $1\frac{1}{2}$ as long as deep. Scales 24–27 $\frac{3\frac{1}{2}-4\frac{1}{2}}{4\frac{1}{2}}$, $2\frac{1}{2}$ between lateral line and ventral, 12 round caudal peduncle. Olive-brown above, yellow on the sides and below; a series of black dots on the lateral line, and a black band on each side of the caudal peduncle; fins white.

Total length 120 millim.

Several specimens from the Kribi River and from Efulen.

Allied to *B. camptacanthus* Blkr. and *B. potamogalis* Cope. Differs from both in the stronger third simple dorsal ray, the more numerous scales in the lateral line (24–27 instead of 21–24), and the coloration. From the first in the longer posterior barbel, from the second in the longer barbels, the smaller eye, and the broader interorbital region.

15. Barbus batesii, sp. n. (Plate III. fig. 2.)

Depth of body equal to length of head, $3\frac{2}{3}$ times in total length. Snout rounded, 3 times in length of head; diameter of eye 5 times in length of head, interorbital width 3 times; mouth inferior, its width 4 times in length of head; lips well-developed, lower continuous; barbels two on each side, subequal, nearly twice as long as eye, the distance between them half their length. Dorsal IV 8, last simple ray strong, bony, not serrated, slightly curved, $\frac{2}{3}$ length of head; free edge of the fin emarginate; its distance from the occiput less than its distance from the caudal. Anal III 5, longest ray $\frac{1}{2}$ length of head. Pectoral $\frac{3}{4}$ length of head, not reaching ventral; latter below anterior rays of dorsal. Caudal peduncle $1\frac{1}{2}$ as long as deep. Scales $30\frac{4\frac{1}{2}}{4\frac{1}{2}}$, 3 between lateral line and ventral, 12 round caudal peduncle. Brownish above, the scales darker at the base, white beneath; fins greyish.

Total length 235 millim.

A single specimen from the Kribi River.

This is the first discovered West African representative of the *B. bynni* group. Its nearest ally is *B. tanensis* Gthr., from the Tana River, East Africa.

16. Barbus kessleri Stdr.

17. Barbus guirali Thomin.

18. Barilius ubangensis Pellegr.

19. Barilius kingsleyæ Blgr.

Siluridæ.

20. Clarias liberiensis Stdr.

21. Chrysobagrus longipinnis Blgr.

22. Auchenoglanis ballayi Sauv.

23. Amphilius longirostris Blgr. (Plate I. fig. 3.)

Anoplopterus longirostris Bouleng. Ann. & Mag. N. H. (7) viii. 1901, p. 447.

Depth of body 9 times in total length, length of head 4 times. Head longer than broad; eyes small, in the second half of the head, two diameters apart; interocular width $\frac{2}{5}$ length of snout,

which is rounded and projects a little beyond lower jaw; posterior nostril midway between eye and end of snout; præmaxillary teeth forming a very short band, measuring about $\frac{1}{4}$ width of mouth; maxillary barbel $\frac{2}{3}$ length of head, reaching root of pectoral; mandibular barbel $\frac{1}{2}$ length of head. Dorsal I 6, nearer end of snout than root of caudal, first ray $\frac{2}{3}$ length of head. Adipose short, as long as dorsal. Anal I 5, midway between root of ventral and root of caudal. Pectoral a little longer than ventral, $\frac{2}{3}$ length of head. Caudal forked. Caudal peduncle $1\frac{1}{2}$ as long as deep. Dark olive-brown above, mottled with black, white beneath; dorsal, pectorals, and ventrals light, with two transverse series of blackish spots; caudal whitish, with some black spots, black at the base, with a large black blotch on each lobe.

Total length 77 millim.

A single specimen from hills in the Bulu country, near Efulen.

24. Synodontis obesus Blgr.

Microsynodontis, gen. nov.

Closely allied to *Synodontis*, differing only in the absence of a free orbital border and of suborbital bones, in the more elongate form and the rounded caudal fin, and in the curious modification of the transverse processes of the fourth vertebra.

25. Microsynodontis batesii, sp. n. (Plate IV.)

Depth of body 5 to 6 times in total length, length of head $4\frac{1}{2}$ to 5 times. Body subcylindrical or feebly compressed in the præcaudal region, strongly compressed behind; vent in the middle of the total length. Head broader than deep, $1\frac{1}{4}$ to $1\frac{1}{3}$ as long as broad, without ridges or keels; skin on vertex, occiput, and nuchal shield adherent to the finely rugose bones; a small frontal fontanelle; eye directed upwards, in middle of head, its diameter 6 or 7 times in length of head, twice in interorbital width. Lips moderately developed; maxillary barbel simple, nearly as long as head; mandibular barbels with long, slender branches; outer mandibular barbels $\frac{4}{5}$ length of head, inner $\frac{2}{5}$. Præmaxillary teeth small, forming a villiform band; mandibular teeth much shorter than the eye, 20 to 30 in number. Gill-cleft restricted to the sides. Occipito-nuchal shield a little longer than broad, ending in two rounded processes. Humeral process narrow, sharply pointed, rugose. Skin smooth. Dorsal I 6; spine strong, straight, striated but not serrated, about $\frac{2}{3}$ length of head. Adipose dorsal low, elongate, 2 to 3 times as long as its distance from the rayed dorsal. Anal III–IV 8–9. Pectoral spine $\frac{2}{3}$ to $\frac{3}{4}$ length of head, strong and striated, with feebly serrate outer edge, with 12 to 17 strong retrorse teeth on the inner side. Ventral not reaching anal. Caudal rounded. Dark brown or blackish, with 5 yellowish cross-bars above, the first on the occiput, the second at the base of the dorsal; the body lower down with round yellowish spots; throat and belly greyish, spotted or marbled wit[h]

dark brown; fins spotted with dark brown, caudal yellowish at the base.

Total length 100 millim.

Several specimens from the Mvile River.

The vertebral column consists of 38 vertebræ, 13 præcaudals and 25 caudals. The first 7 are completely united, and the transverse processes of the 4th, which form the spring-mechanism in *Synodontis*, have a very extraordinary form. This process bears a spheroidal expansion in front, whilst behind, where it presses against the bladder, it is slightly excavated or cup-shaped. It may be described as similar to its homologue in *Synodontis*, but with a large, bell-shaped, bony knob attached to its anterior surface. The air-bladder is large, as in *Synodontis*. The male genital gland is very peculiar, being lacerated into numerous digitiform lobes.

Cyprinodontidæ.

26. Haplochilus sexfasciatus Gill.

Epiplatys sexfasciatus Gill, Proc. Acad. Philad. 1862, p. 136 (Gaboon R.).

Pœcilia sexfasciata Peters, Mon. Berl. Ac. 1864, p. 396 (Liberia).

Haplochilus infrafasciatus, part., Günth. Cat. Fish. vi. (1866), pp. 313 & 357 (Old Calabar).

Haplochilus sexfasciatus Günth. l. c.

Lycocyprinus sexfasciatus Peters, Mon. Berl. Ac. 1868, p. 146 (Gaboon).

Epiplatys infrafasciatus Cope, Proc. Amer. Philos. Soc. xi. 1871, p. 457.

Haplochilus infrafasciatus Steind. Notes Leyd. Mus. xvi. 1894, p. 76 (Liberia); Lönnberg, Œfv. Vet.-Ak. Förh. Stockh. 1895, p. 188 (Cameroon).

27. Haplochilus elegans Blgr.

Ophiocephalidæ.

28. Ophiocephalus obscurus Gthr.

Anabantidæ.

29. Anabas maculatus Thomin.

30. Anabas pleurostigma, sp. n. (Plate V. fig. 1.)

Closely related to *A. kingsleyæ* Gthr., but snout longer, as long as the eye in the adult, at least two-thirds the interorbital width. Dorsal XIV–XVI 10–11; anal VIII–IX 10–11. Scales 27–29 $\frac{2\frac{1}{2}}{8}$; lateral line 14–17/10–12. A large round blackish spot on the middle of the side, above the extremity of the pectoral fin; no dark spot at the base of the caudal fin.

Total length 170 millim.

Several specimens from the Kribi River.

CICHLIDÆ.

31. PELMATOCHROMIS BATESII Blgr.

Recently described from the Benito River.

32. PELMATOCHROMIS SUBOCELLATUS Gthr.

33. TILAPIA LATA Gthr.

MASTACEMBELIDÆ.

34. MASTACEMBELUS LOENNBERGII Blgr.

28 dorsal spines. Length of head $3\frac{1}{2}$ times in its distance from vent.

35. MASTACEMBELUS SCLATERI, sp. n. (Plate V. fig. 2.)

Depth of body 12 to 13 times in total length, length of head (without rostral appendage) 6 to 7 times; vent equally or nearly equally distant from end of snout and base of caudal; length of head $2\frac{1}{4}$ to $2\frac{3}{4}$ times in its distance from vent, and $\frac{1}{4}$ to $\frac{2}{7}$ in its distance from first dorsal spine. Snout 3 times as long as eye, ending in a trifid dermal appendage which is longer than eye; cleft of mouth extending hardly to below nostril; a strong præorbital and two strong præopercular spines. Vertical fins united with rounded caudal. Dorsal XXVI–XXVII 85–90; spines very short. Anal II 80–90. Pectoral not quite $\frac{1}{3}$ length of head. Scales very small, 19 or 20 between origin of soft dorsal and lateral line. Olive-brown, whitish on the belly; a dark band on each side of the head, passing through the eye, sometimes continued on the anterior part of the body; a more or less distinct series of large, dark, light-edged ocelli along the base of the dorsal.

Total length 225 millim.

This new species, named after our retiring Secretary, Mr. P. L. Sclater, in recognition of many favours received from him during his tenure of office, is based on four specimens from the Mvile River. *M. sclateri* differs from *M. marchii* Sauv. in the more numerous dorsal spines, from *M. cryptacanthus* Gthr., *liberiensis* Blgr., and *loennbergi* Blgr. in the larger head, and from *M. congicus* Blgr. in the presence of only two anal spines and the still smaller scales.

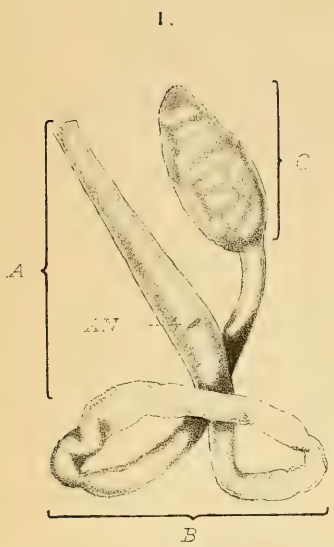
EXPLANATION OF THE PLATES.

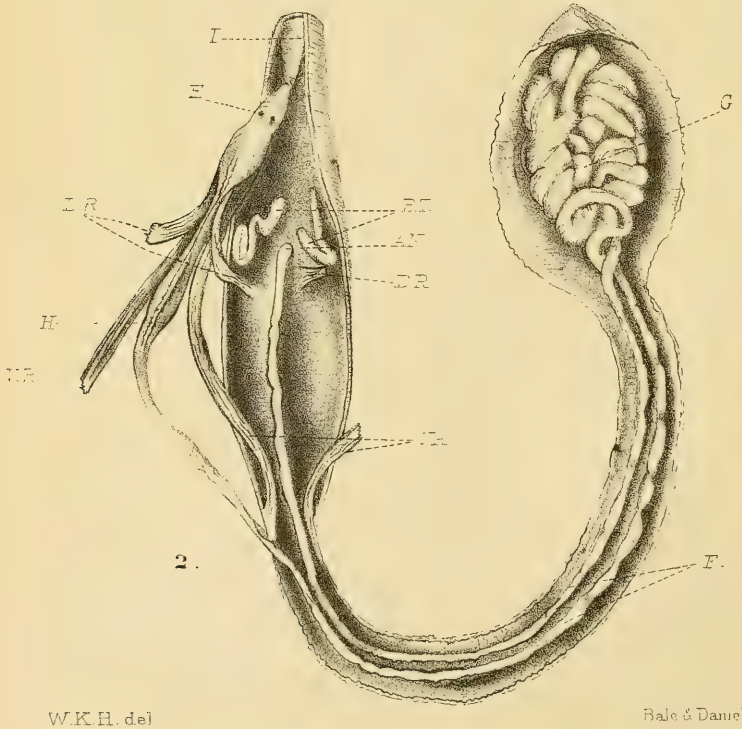
PLATE I.

Fig. 1. *Alestes intermedius*, p. 22, natural size.
2. *Alestes opisthotænia*, p. 22, $\frac{2}{3}$.
3. *Amphilius longirostris*, p. 25, natural size.
3*a*. „ „ Upper view of head and pectoral fin, × $1\frac{1}{2}$.
3*b*. „ „ Lower view of head, × $1\frac{1}{2}$.

PLATE II.

Fig. 1. *Labeo annectens*, p. 23, $\frac{4}{5}$.
2. *Barbus tæniurus*, p. 24, natural size.





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ANATOMY AND HISTOLOGY OF PHASCOLOSOMA TERES.

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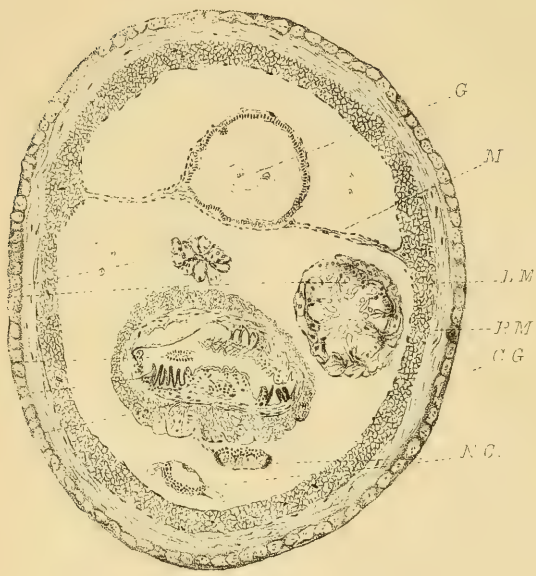

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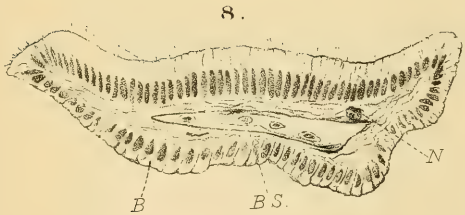

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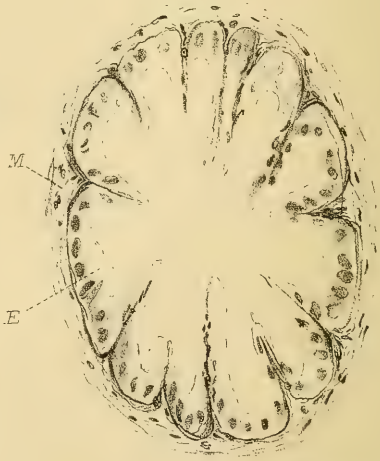

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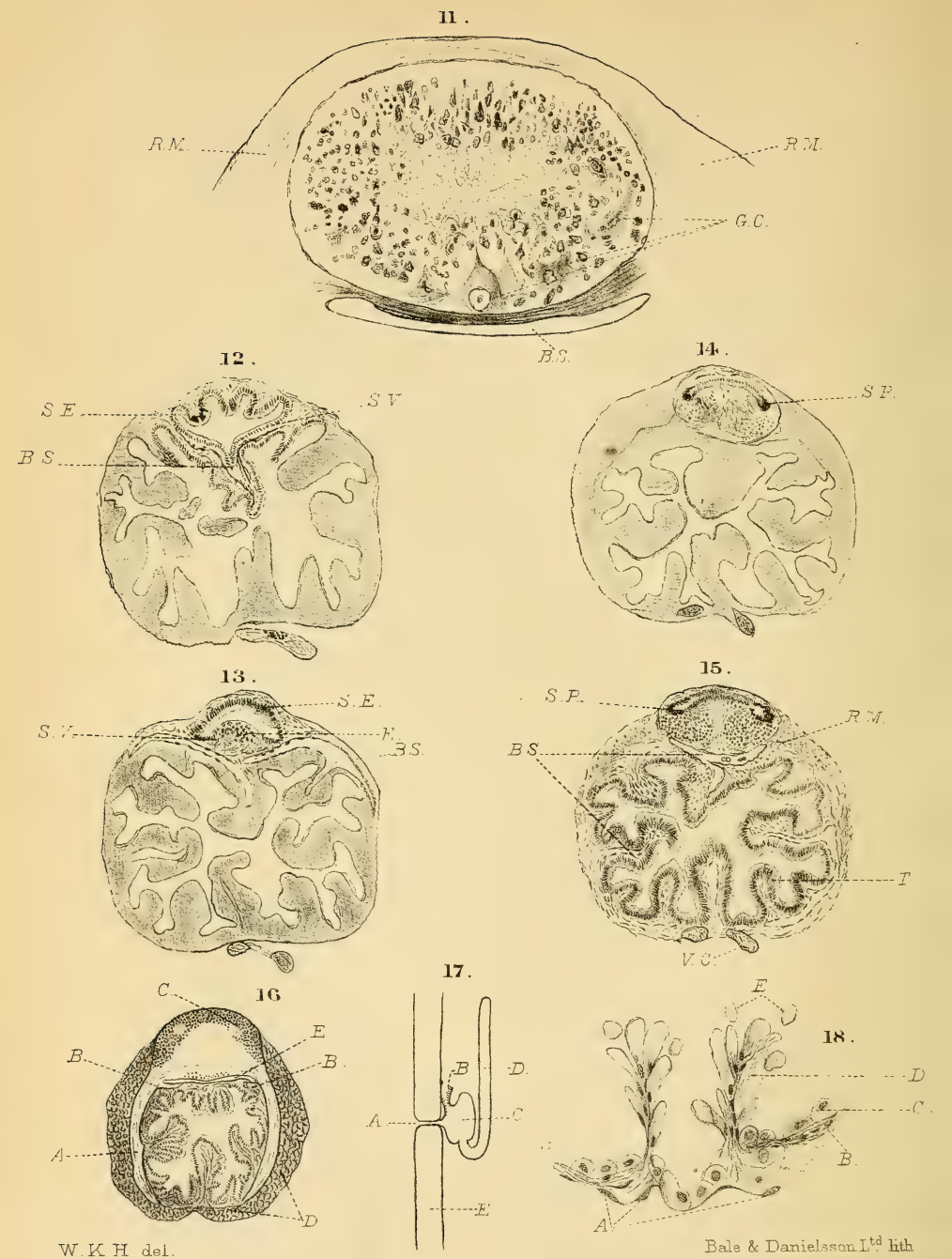
ANATOMY AND HISTOLOGY OF PHASCOLOSOMA TERES.



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ANATOMY AND HISTOLOGY OF PHASCOLOSOMA TERES.

PLATE III.

Fig. 1. *Barbus progenys*, p. 24, $\frac{5}{7}$.
2. *Barbus batesii*, p. 25, $\frac{5}{7}$.

PLATE IV.

Microsynodontis batesii, p. 26.
a. The whole fish, natural size.
b. Mouth, × 2.
c. Skeleton, natural size.
d. Upper view of skull, shoulder-girdle, and nuchal shield, × 1½.
e. Side view showing air-bladder and anterior part of vertebral column, × 2.
f. Left transverse processes of coalescent anterior vertebræ, × 3.

PLATE V.

Fig. 1. *Anabas pleurostigma*, p. 27, $\frac{5}{7}$.
2. *Mastacembelus sclateri*, p. 28, natural size.

4. On the Anatomy of the Gephyrean *Phascolosoma teres*, n. sp. By W. K. HUTTON, M.A., M.B., Senior Demonstrator of Anatomy in the University of Glasgow.

[Received November 6, 1902.]

(Plates VI.–VIII.[1] & Text-figure 9.)

Some time ago, while engaged in dredging-operations in the Firth of Clyde, Dr. J. F. Gemmill obtained two specimens of the Gephyrean worm figured in Plate VI. fig. 1. These he handed over to me, and at his suggestion I undertook the task of identifying them. My examination having led me to the conclusion that I was dealing with an animal hitherto undescribed, it seemed advisable to give some account of its anatomy; and this I have essayed to do in the following pages.

Unfortunately the presence of sand in the alimentary tract, no less than the leathery nature of the animal's skin, formed an almost insuperable obstacle in the way of obtaining continuous series of sections: as a result, my account is in some respects incomplete. The worm was dredged from a depth of 60 fathoms, nine miles to the south-west of the Corsewall Light. The bottom was fine mud.

External Characters and Integument.

The worm is shaped like a very long-necked Florence oil-flask and measures 40 mm. in length. Since, however, in both individuals examined the introvert was almost completely invaginated, in order to estimate the true length probably 8 mm. must be added to this figure. The body of the worm is seen (Plate VI. fig. 2) to consist of three portions which differ externally, and are found upon dissection to have definite relations to the contained viscera.

First, occupying the anterior third or more of the animal's

[1] For explanation of the Plates, see p. 40.

length, and containing within it the more important organs, comes fa airly stout and muscular portion 2 mm. in diameter (Plate VI. fig. 1, A). This gradually passes posteriorly into a much slighter, less muscular, and longer part, which extends for more than the middle third of the length and measures 1 mm. in thickness; while lastly, there is a short, thick, ellipsoidal piece, measuring 5 mm. by 2·5 mm., having very thin walls which are transparent enough to allow the coils of gut within to be dimly seen. This terminal portion is quite sharply demarcated from the rest of the body, and forms a sack in which the coiled portion of the intestine (Plate VI. fig. 2, G) is contained.

The colour of the spirit-specimens is a pale yellow over the anterior three-fourths of the animal's length; on the thick terminal part the tint is a dirty bluish white, the contents of the intestine appearing through the body-wall as brownish markings.

The skin has a slightly iridescent sheen; it is entirely devoid of papillæ and is of a leathery toughness. It is studded with the openings of innumerable cuticular glands (Plate VII. fig. 6, C.G.). These glands (Plate VI. fig. 3) are spheroidal, and measure ·05 mm. in diameter. Each is lined with a single layer of rather flattened cells (L), and the majority are completely filled with small yellow, highly refractive granules (I). The glands on the introvert are very much smaller, and granules are not so plentiful in them as elsewhere.

Though definite papillæ are not found, tegumentary appendages are represented on the introvert by chitinous hooks. These are arranged in a series of ten transverse rows (Plate VI. fig. 4). The individual hooks vary in length (Plate VII. fig. 5) from ·06 to ·08 mm.; they are brown in colour, almost black at the tip, are but slightly curved, and the isolated hooks shown in the figure are grooved on their concave edge for about two-thirds of their length (Plate VII. fig. 5, F). Each hook has a small multicellular epidermal core. The first part of the introvert, that nearest the "head" of the animal, is perfectly smooth, and, when invaginated, abuts against the outer surface of the tentacular crown throughout two-thirds of its length; for the remaining distance, however, the tentacles touch the hook-bearing part. Laceration of the tentacles during evagination and invagination is averted in some Sipunculids by the presence of a "collar," which intervenes between these delicate structures and the rough introvert. Here there is no such provision; the end is gained by a transverse furrowing of the skin on the hook-bearing introvert during invagination; and by this means the hooks, projecting from the base of the groove, barely come into contact with the tentacles. An indication of this condition is represented in fig. 6, H.I. (Plate VII.).

General Arrangement of Organs.

Figure 2 (Plate VI.) is a drawing of a dissection of the worm. It has been opened along the ventral aspect, and the two retractor

muscles (D.R., V.R.) of the left side have been cut through. The anterior part of the alimentary canal has been twisted aside and turned so that it presents to view its dorsal surface. The introvert is almost completely invaginated, the real "head" of the worm being about the position of the two eye-spots (E).

The internal aspect of the body-wall has a glancing appearance like mother-of-pearl; the longitudinal muscles form a continuous sheet with no division into strands. There are four retractor muscles (D.R., V.R.), two dorsal and two ventral. The latter are more than twice the length of the former, stretching from the termination of the anterior muscular part of the body (between A & B, fig. 1) to the anterior part of the œsophagus, where they fuse with the dorsal muscles to form a sheath for that tube. They arise, one on either side of the nerve-cord. The dorsal muscles are attached to the body-wall on either side of the hind-gut, a little way behind the anus. In fig. 2 the only part of the nervous system seen is the eye-spots, which are visible in a dissection as a couple of black specks shining through the walls of the introvert.

The alimentary canal (G.F.), with the exception of the anterior part of the œsophagus, is shown in full. It is, like the worm itself, divisible into three parts, an anterior and a posterior portion, comparatively straight, and a middle piece (G) exceedingly coiled.

In the drawing, for the sake of clearness, that part of the gut (F) contained in the thin portion of the worm is shown as though absolutely straight; it is really slightly crumpled. Nowhere is there any intestinal spiral; there is no spindle-muscle, and the intestine is entirely free except for about 2 mm. behind the anus, where the rectum is attached to the body-wall by thin radially-disposed strands of muscular fibre, which in sections (Plate VII. fig. 6, M) appear to divide the cœlom into dorsal and ventral portions. The nephridia are noticeable objects in a dissection (fig. 2, B.T.) on either side of the anus. All that is visible of the blood-vascular system is the tortuous dorsal vessel (H). The generative organs are visible only in microscopic preparations.

Musculature.

The dermo-muscular tube has the arrangement common to the Phascolosomidæ. Underneath the integument there lies a layer of circularly-disposed fibres (Plate VII. fig. 6, R.M.), and beneath this again one of fibres having a longitudinal direction (L.M.). As already mentioned, this latter layer is a continuous one, with no division into strands such as are seen, for example, in the genus *Sipunculus*. The musculature is thickest and strongest in the anterior third of the animal's body; becoming thinner as the body narrows, it reaches the extreme of tenuity over the ellipsoidal posterior part, the thinning of the tube appearing to take place at the expense of the circular layer.

Around the anus and the external nephridial apertures, both layers furnish special sphincter-fibres; while along either side of the nerve-cord, as is afterwards noted, there runs a slender longitudinal strand of muscle-fibre (N.C., fig. 6).

The general arrangement of the four special retractor muscles of the introvert and of the radial rectal muscular attachments have already been described; there remains only, in regard to the former, to speak of the special appearance presented by the muscular fibres in this worm. On comparing the ventral retractors with the general longitudinal musculature, one is struck by the great similarity of texture presented by both. A glancing, bright suggestion of firmness, reminding one of the surface of fresh tendon among the higher forms, is noticeable. The dorsal retractors, on the other hand, have a dull, almost a translucent appearance. Microscopical examination of transverse sections reveals little difference between the two sets of muscles, save only that in a given area fewer muscular fibres are present in the dorsal muscles, and the amount of intermuscular connective tissue appears to be greater than in similar sections of the ventral set (Plate VII. fig. 7, A & B). On the whole, both from the relatively marked shortness of the dorsal muscles and from the appearances just described, I incline to suspect that they cannot be functionally very active. They contain a sufficient amount of connective-tissue between the proper muscular bundles to make the suggestion that they are in a state of metamorphosis and regression at least probable (*vide* J. Bland Sutton's 'Ligaments,' &c., 2nd ed., 1897, p. 3 *et seq.*).

Alimentary Canal.

Surrounding the mouth, which lies at the bottom of the depression formed by the union of their bases, are several simple leaf-shaped tentacles. So far as could be ascertained by the examination of a series of sections, 15 tentacles are present, and of these 11 are longer than the others. Each tentacle contains a branch of the blood-sinus and a slender nerve (Plate VII. fig. 8). This figure, which represents a typical transverse section of a tentacle, shows that on the mesial aspect the cells covering its surface are narrow, long, arranged in palisade form, and are ciliated, while those of the opposite side form a simple columnar epithelium. For the greater part of their extent the tentacles are free, but round the mouth their bases are fused together, and form a series of gutters which lead to the oral aperture.

The mouth itself lies on the top of a papilla, whose sides are grooved by the above-mentioned furrows. The cells lining the grooves are cubical and ciliated, and are continuous with the ciliated epithelium on the mesial aspect of the tentacles. Succeeding the mouth is a short œsophagus with very muscular walls; in section (Plate VII. fig. 10) it appears to be star-shaped, the lumen of the tube being encroached upon by the inward projection of a

series of papillæ whose epithelial covering is apparently devoid of cilia.

For the reason mentioned at the beginning of this paper, it was no easy matter to gain a certain knowledge of the histology of the alimentary tract. Figure 9 A (Plate VII.) shows the character of the epithelium of the mid-gut generally: lying upon the thin muscular wall are narrow cells of varying length, with a basal nucleus and granular cytoplasm; the outlines between the several cells were in many places most indistinct. The epithelium of the rectum (fig. 9 B) is composed of cubical cells, with a distinct margin on the surface next the lumen of the gut. They possess cilia, and were the only cells in the alimentary tract in which the presence of a ciliated border could with certainty be determined.

Circulatory System.

This consists of a dorsal vessel, a sinus surrounding the base of the tentacles, and tentacular vessels.

The dorsal vessel is single, and though convoluted it is devoid of diverticula: coursing along the dorsal wall of the fore gut, it surrounds the base of the tentacles with a circular sinus into which the brain dips (Plate VIII. figs. 11, 15, 16); from this circular vessel tentacular sinuses arise, they form noticeable objects in sections of the tentacles (Plate VII. fig. 8, B.S.).

Nervous System.

This is of the usual type, and consists of a brain, a ventral nerve-chain, and a couple of sense-organs.

The brain is a small, somewhat cordiform body, measuring in its long axis, which corresponds with that of the animal, three-tenths of a millimetre; it lies on the dorsal wall of the pharynx at the base of the tentacles; it is surrounded by a fine capsule of connective-tissue, and the anterior surface in addition is covered by an epithelium (Plate VIII. fig. 13, E.), which is continuous with that of the outer non-ciliated aspect of the tentacles; laterally, the muscular tube formed by the union of the retractors abuts upon it (fig. 15, R.M.); below the brain is the blood-sinus (B.S., figs. 11, 13, 15) from which the tentacular vessels arise.

The majority of the cerebral cells are small, with a clear cytoplasm and relatively large nuclei; they are massed anteriorly, dorsally, and posteriorly: the central and greater part of the ventral aspect of the brain are composed of fibres, but behind the point of origin of the circumœsophageal commissures there are to be seen in the lower cortical part several very large ganglion-cells (G.C., fig. 11): these giant cells measure ·03 mm. in diameter; some are pyriform, others irregular in shape, and these appear to be multipolar, unlike those of *Phymosoma* (Shipley, No. 7.[1]), but on this point I cannot be absolutely definite.

[1] This number has reference to the list of authors quoted on p. 40.

From the brain two pairs of nerves arise. The first pair (Plate VIII. fig. 16, B), which are very slender, take their origin from the ventral aspect of the ganglionic mass just anterior to the eye-spots; from them twigs pass to supply the epineural canal and apparently also the two dorsal tentacles. The remaining tentacles receive their nerves from the two stout circumœsophageal connectives (fig. 16, A), which constitute the second pair of nerves, and arise ventro-laterally behind the eye-spots, coursing round the base of the tentacular crown, between it and the muscular tube formed by the fusion of the retractor muscles. Ventrally, the circumœsophageal commissures unite to form the nerve-cord. This shows no trace of segmentation. Dorsally it is composed of fibres, while ventrally nerve-cells are distributed evenly along its whole length. It is accompanied laterally by two fine muscles, as is usual in the Sipunculidæ.

Sense-Organs.

In tracing back series of sections, there becomes apparent on the dorsal wall of the pharynx a patch of long-celled columnar pigmented epithelium. The cells of this layer are found (Plate VIII. figs. 12, 13, 14, 15, S.E.) to be the dorsal wall of a slit-like canal, whose ventral wall is formed by cells which, on the one hand, cover the brain in front, and on the other are continuous with the non-ciliated epithelium which clothes the outer aspect of the two dorsal tentacles (S.V.), which are seen in fig. 12 to have united along their mesial margins.

Posteriorly the canal thus formed (which may be called the *epineural canal*) becomes very narrow centrally, and ends blindly by dividing into two little *culs-de-sac* (S.P., fig. 15), which project downwards and outwards into the cerebral cortex, and are lined by a columnar epithelium the cells of which are deeply laden with granules of a reddish-black pigment.

The cup-like organs thus formed are usually called "eye-spots," and are present in at least four other species of *Phascolosoma*, but, so far as I am aware, no account of their structure has hitherto been published. Their existence in an animal which lives at a depth so great as that of 60 fathoms is noteworthy, and appears to me to argue for the organs in question some function other than even merely photometric; but a small fraction of diffused daylight can permeate so far. They are always to be found in the genus *Phymosoma*, and from the above-given description it will be seen that the sense-organs of *Ph. teres* resemble in the main those of *Phymosoma varians* (Shipley, 7). They differ, however, from those of *Phymosoma* in their relations to the tentacles.

In the genus *Phymosoma* the cells entering into the formation of the eye-spots are continuous, on the one hand, with the epithelium covering the anterior aspect of the brain, and, on the other, with those which constitute the lining of the mesial surface of the tentacles. In *Phascolosoma*, on the contrary, the sensory epi-

thelium is furnished by a tentacular surface which is apparently external.

This seeming discrepancy is readily explained by a reference to the following diagrams (text-fig. 9), modified from Selenka, in which A represents the position of the mouth, B that of the cerebral ganglion, while thick-dotted lines indicate the relations of the tentacular wreath.

In text-fig. 9 *a* this wreath is seen surrounding the mouth with a simple circlet, as in *Phascolosoma teres*. In such a case the infundibuliform approach to the cerebral organ must be lined by cells, continuous not only with cells of the introvert epidermis but with those covering the outer aspect of the tentacular chaplet.

Text-fig. 9.

Tentacular wreath of (*a*) *Phascolosoma* and (*b*) *Phymosoma*.

In text-fig. 9 *b* the crown of tentacles is seen to have been indented in its upper (neural) part, and the edges of the indentation have been bent up in such a manner as to form a horseshoe-shaped lophophore which, partially encircling the brain, overhangs the mouth instead of surrounding it. The finely dotted line in the diagram represents the position of the "lower lip" in *Phymosoma*; this may be looked upon as corresponding to the fused bases of aborted tentacles. Here, then, the brain, lying at the base of the lophophore, can only be approached by a canal whose walls are coated by an epithelium continuous with that covering the mesial surface of the tentacles.

The arrangement seen in *Phascolosoma* is the more primitive. Briefly stated, tentacular surfaces which are inner and outer in the genus *Phascolosoma*, become outer and inner respectively in *Phymosoma*, owing to the secondary indentation of the crown of tentacles.

According to Shipley (*loc. cit.*), the space included within the concavity of the lophophore of *Phymosoma* becomes the representative of the "præoral lobe" of *Phoronis*.

Although nowadays, in virtue of our knowledge of the totally distinct modes of development of the tentacles in *Phoronis* and the Sipunculids, it does not seem possible to institute any homology between the lophophoral crowns of *Phoronis* and *Phymosoma*, yet it may be of interest to note that in the species of Sipunculid under consideration the homologue of the pigmented epithelium, which in *Phymosoma* covers Shipley's "præoral lobe," is to be found in that layer of pigmented cells (Plate VIII. fig. 12, S.E.) which forms the dorsal wall of the epineural canal as well as in that layer continuous with it, bounding the anterior surface of the brain (fig. 13, E.).

Nephridia.

These are small (Plate VI. fig. 2, B.T.), measuring less than the twentieth part of the length of the worm; the right nephridium is the longer and more convoluted of the two. Each organ is retort-shaped (Plate VIII. fig. 17), having a bulbous portion (C) attached to the body-wall, and a tubular part (D) which, arising from the posterior part of the bulb, bends round it mesially and projects freely forwards into the cœlom. The wall of the bulb is thin, covered externally by the cells of the peritoneum (A, fig. 18), and internally by a single layer of granular-looking columnar epithelium (C, fig. 18); it is composed of slender intercrossing muscular bands. The cavity of the bulb is packed with fine vesicles (E, fig. 18), which, it will be seen, are derived from the secreting epithelium of the tubular portion of the nephridium. The bulb communicates with the exterior by a fine canal (A, fig. 17), lined with a small-celled epithelium, which pierces the body-wall immediately in front of the anus, and its cavity is, further, placed in connection with the cœlomic space through a slit-like opening (B, fig. 17) in front of the excretory canal. The lips of this opening, lined with ciliated epithelium, lie between the body-wall and the bulbous part of the nephridium, and are concealed by its overhanging anterior extremity. The tubular portion of the organ has a wall which is formed by a peritoneal lamella, beneath which is a layer of muscles (B, fig. 18). This muscular layer consists of a meshwork of strands, between interstices of which the lining-epithelium bulges outwards, forming little crypts lined with a single layer of secretory cells (C). In cross section there are seen projecting into the lumen of the tube feathery columns of cells (D, fig. 18), which have an appearance comparable to that of goblet-cells. The nucleus is small and irregular in shape, placed basally; while the cell-contents may be seen to become clearer near the free margin, and are evidently extruded ultimately as the thin-walled vesicles which are found filling the lumen of the organ.

Shipley aptly compares the process, which takes place also in *Phymosoma*, to the formation of the granules excreted by the cells of the mammary gland.

The Generative Organs.

Stretching across the ventral aspect of the cœlom, at the point where the ventral retractors are attached to the body-wall, is a band of cells with relatively large nuclei. These cells constitute the *genital band* and are derived from the peritoneal epithelium. In the single worm examined, neither free ova nor spermatozoa were to be seen in the body-cavity.

Systematic.

The presence of hooks and the possession of four retractor muscles are characters which at once place *Phascolosoma teres* in the first of the five "groups" into which Selenka (5) divides the genus. At the time of publication of his 'Die Sipunculiden' three species alone (*Ph. vulgare*, *Ph. elongatum*, and *Ph. cylindratum*) composed the group. To these must now be added, as well as *Ph. teres*, *Ph. sanderi* Collin (1) and *Ph. lobostomum* Grube (Fischer, 2). The position of *Phascolosoma abnormis* Sluiter (6) must in the existing state of classification remain doubtful, as the whole anterior end of the animal was wanting.

The nearest ally of *Ph. teres* in the group is *Ph. elongatum* (see Keferstein, 3). Both have the same arrangement of tentacles and the same number of rows of hooks, while the hooks themselves are very similar. *Ph. teres*, however, differs widely in the proportionate length of its introvert, and, as regards its internal anatomy, in the small size and unequal bulk of the nephridia, in the absence of any definite spiral coiling of the intestine, in the great length of the hind-gut, and in the absence of a spindle-muscle; and, as well as in these particulars, in its characteristic habit of body. From every other member of the group except *Ph. cylindratum* it differs in the complete absence of papillæ. These peculiarities warrant the systematic zoologist in assigning to the animal under discussion a distinct place in the genus, and I propose for it the name of *Phascolosoma teres*.

That the genus *Phascolosoma* is an eminently variable one is evident to any investigator who makes a systematic study of the Sipunculidæ; and that this tendency to variation may result in the inclusion in one small sub-group of animals which differ in an astonishing extent in external habit, is abundantly exemplified by the fact that *Phascolosoma teres* and *Ph. sanderi* (Collin) — two worms so dissimilar that a casual observer would be pardoned for placing them in different genera—must yet, in the present rather unsatisfactory state of classification, be united in the group called by Selenka "Group I." of the Phascolosomidæ; yet, while the latter was considered by its describer Collin to present points of resemblance to that curious Sipunculid *Golfingia macintoshii* (8), and seems to have points in common with *Aspidosiphon*, the former appears to me to present in its structural peculiarities definite affinities to the sedentary *Phascolion*. Roule (4), who

investigated the Phascolosomidæ obtained by the 'Travailleur' and 'Talisman,' in speaking of classification, goes the length of saying, "L'espèce bien affirmée n'existe pas dans le genre *Phascolosome*"; and by this somewhat strong assertion he would indicate that the genus is in such a plastic condition—in a state of fluctuating variability as one may term it—that it is capable of being influenced by what Semper called "the conditions of existence" in such a way, that within the genus we may have numbers of types, differing on the whole but little from one another, the links of their genetic affinity easily supplied, which yet point the way toward the probable origin of the other Sipunculid genera. As Roule expressed it: "Ce genre est encore en voie de transformation, il se morcelle en un grand nombre de types peu dissemblables, et ne se divise point en espèces précises, dont les variations s'enserrent dans des limites peu éloignées." Roule's investigations led him to the conclusion that the Phascolosomidæ examined by him formed a series of links connecting the parent *Phascolosoma* stock with *Aspidosiphon*. In the phylogenetic table drawn up provisionally by Selenka in his beautiful monograph 'Die Sipunculiden' (page 6), a polyphyletic origin is suggested for both *Phascolion* and *Aspidosiphon*. The former may have arisen directly from the parent Phascolosomid, or from a common stem (similarly derived) which branches into *Onchnesoma*, *Tylosoma*, and *Phascolion*; while *Aspidosiphon* may have been derived from the directly produced *Phascolion*, or from a stem common to itself, *Phymosoma*, and *Cloeosiphon*.

In *Phascolosoma teres* we have, as it appears to me, not perhaps an actually intermediate type, but at the least a species which gives us hints as to the probable path taken in its phylogenetic course by *Phascolion*; while the species examined by Roule play the same rôle as regards the genus *Aspidosiphon*. *Phascolosoma sanderi*, though considered by Collin to approach *Golfingia*, has a distinct but superficial resemblance to *Aspidosiphon*, and was rightly, as I think, placed by its describer in the genus *Phascolosoma*.

In the worm which forms the subject of this paper the following characters suggest *Phascolion*-like affinities:—The differing bulk of the two nephridia, the relatively feeble development of the dorsal retractors (a character upon which Roule placed much reliance in his investigations), the lack of spindle-muscle, and the coiled, but not spirally-wound gut,—all these are peculiarities which place the worm in closer relationship with *Phascolion* than with any other of the groups derived from the original Phascolosomid stock.

Information as to the habits of *Phascolosoma teres* is wanting; but in its mode of life it is probably sluggish, lying buried in soft ooze with its anterior end alone projecting. The thin-walled bag-like posterior portion, endowed with but feeble muscularity, so sharply demarcated from the rest of the body, so relatively large, would undoubtedly act as a hindrance to active locomotion

through sand or mud. Most species of *Phascolion* live with the posterior part of the body either embedded in mud or protected by some cast-off mollusk-shell; and if we assume, as the external habit of *Phascolosoma teres* seems to me to warrant, this similarity of mode of life between the two types, certain peculiarities of structure in *Ph. teres* become of easy explanation.

Selenka, long ago, pointed out that those Sipunculids which live in shells usually have only one nephridium. In other words, in animals of sluggish habit, the needs of metabolism are served by one excretory tube.

Now in *Ph. teres*, while there are two nephridia, they are both small and are of different sizes; the left has retrograded to a greater extent than the right. It is to be noted that when only one nephridium persists—as in *Phascolion*—it is that upon the right side.

Enfeeblement of the muscular system is correlated with inactive habits; and in worms lying half buried in mud a strongly developed system of retractors ceases to be a clamant need. The extreme case is reached in *Phascolion*, where often the ventral retractors alone remain, while an indication of regression of the dorsal retractor system is seen (*vide supra*) in *Phascolosoma teres*.

Lastly, in this worm, the coils of intestine, completely filling up the sharply-delimited posterior part of the body, could scarcely be efficiently acted upon by any spindle-muscle, which, we see, is absent.

In these structural characters, then, we seem to obtain in *Ph. teres* an indication of the path taken by *Phascolion* in its derivation from the more primitive *Phascolosoma*.

Summary.—With the characters of the Group.

Phascolosoma teres, n. sp.

Body 40 mm. long, introvert ca. 8 mm. Posterior portion stout, sharply demarcated, ellipsoidal, containing the coiled portion of the gut.

Colour yellowish, merging to dirty bluish white over the posterior part.

Skin smooth, iridescent, devoid of papillæ, translucent posteriorly, beset with numberless glands. A simple wreath of 15 tentacles surrounds the mouth. Forward on the introvert 10 rows of backwardly directed, slightly curved, brownish hooks, ·06–·08 mm. long.

Two eye-spots. Alimentary canal free, without spindle-muscle or mesenterial attachment save close to the anus. Spiral winding absent, but the tube much coiled in its middle portion. Hind-gut very long. Two nephridia, the right the larger, one-twentieth of the body-length. Simple contractile vessel.

Hab. Firth of Clyde. Dredged from 60 fathoms.

Works referred to.

(1) A. Collin.—"Gephyreen gesammelt von Herrn Stabsarzt Dr. Sander," in Archiv für Naturgeschichte, lviii. p. 197, 1892.

(2) Fischer.—"Die Gephyreen des Naturhistorischen Museums zu Hamburg," in Abhandlungen aus dem Gebiete der Naturwissenschaften &c., Hamburg, Bd. xiii. p. 1, 1895.

(3) Keferstein.—"Beiträge zur Kenntniss der Gattung *Phascolosoma* F. S. Leuck.," in Zeitschrift für wiss. Zoologie, Bd. xii. p. 35, 1862.

(3 *a*) Keferstein.—"Beiträge zur anatomischen und systematischen Kenntniss der Sipunculiden," in Zeitschrift für wiss. Zoologie, Bd. xv. p. 404, 1865.

(4) Roule.—"Sur le Géphyriens des grands fonds de la mer recueillis par le 'Travailleur' et le 'Talisman,'" in Comptes Rendus, cxxvii. p. 197.

(5) Selenka.—"Die Sipunculiden," in Semper's 'Reisen.' Wiesbaden, 1883.

(6) C. Ph. Sluiter.—"Beiträge zu der Kenntnis der Gephyreën aus dem Malayischen Archipel," in Natuurkundig Tijdschrift voor Nederlandsch-Indië, Deel xlv. p. 472, 1886.

(7) Shipley.—"On *Phymosoma varians*," in Quart. Journ. Micr. Sci. vol. xxxi., n. s. p. 1, 1890.

(8) Lankester.—"*Golfingia macintoshii*, &c." Trans. Linn. Soc. Lond. 2nd ser., Zool. vol. ii. p. 469, 1885.

EXPLANATION OF THE PLATES.

Plate VI.

Fig. 1. The entire animal, magnified about 6½ times. A, the anterior muscular part. B, the middle thinner portion. C, the bag-like posterior piece. AN., the anus. pp. 29, 30.

Fig. 2. Semi-diagrammatic figure of a dissection, magnified about 13 diam. I, the introvert. E, the eye-spots. B.T., the nephridia. H, dorsal vessel. D.R., dorsal retractor muscles. V.R., ventral retractors. AN., position of anus. G, coiled part of gut. F, straight part. pp. 30, 31.

Fig. 3. Cuticular glands in vertical section. × 290. R.M., radial muscles. C, cuticle. L, secretory cells. I, granular contents. p. 30.

Fig. 4. Hooks from introvert. Surface view. × 154. p. 30.

Plate VII.

Fig. 5. Isolated hooks. × 290. F, furrow. p. 30.

Fig. 6. Transverse section 1 mm. behind the anus. × 53. C.G., cuticular glands. R.M., radial musculature. L.M., longitudinal do. M, muscles attached to rectum. G, rectum. B.T., nephridia. T, tentacle cut across. H, hooks. I, introvert. N.C., ventral nerve-cord and muscles. p. 31.

Fig. 7. Histology of the retractor muscles (Powell & Lealand $\frac{1}{12}$-imm., eyepiece A). A. Transverse section of dorsal retractor, showing amount of interstitial connective between the bundles.
B. Ditto of ventral retractor, showing almost no intermuscular connective. p. 32.

Fig. 8. Transverse section of tentacle. × 290. B.S., blood-sinus. N, nerve. A, ciliated mesial cells. B, columnar outer cells. p. 32.

Fig. 9. A. Epithelium of mid-gut. × 290. B. Epithelium of hind-gut. × 290. p. 33.

Fig. 10. Transverse section of œsophagus. × 290. Part only of the stout muscular wall is shown. M, muscular wall. E, the epithelium thrown into papillæ. p. 32.

PLATE VIII.

Fig. 11. Transverse section of brain behind origin of œsophageal commissures, to show giant ganglion-cells. × 290. R.M., retractors. B.S., blood-sinus. G.C., giant cells. p. 33.

Figs. 12, 13, 14, 15. Four transverse sections through the brain and base of the tentacular crown, to show the epineural canal and formation of the eye-spots. × 53. B.S., blood-sinus. V.C., nerve-cord. R.M., retractor muscles. S.E., sensory epithelium of the dorsal, and S.V., that of the ventral wall of the epineural canal. T, tentacles. S.P., eye-spots. E, epithelium of anterior cerebral surface. p. 34.

Fig. 16. Transverse section through brain and bases of the tentacles, showing the origin of the circumœsophageal commissures (× 53 and reduced). p. 34.
A. Circumœsophageal nerves.
B. Nerves to the epineural canal and dorsal pair of tentacles.
C. Two nerve-strands, in cross section, which seem to be connected with the sense-organs.
D. Fused retractor muscles.
E. Blood-sinus.

Fig. 17. Diagram of a nephridium. A, excretory canal. B, cœlomic pore. C, vesicle. D, tubular part. E, body-wall. p. 36.

Fig. 18. To show histology of tubular portion. × 290. A, peritoneal cells. B, muscular wall. C, secreting cells which at D are seen forming feathery columns. E, vesicles. p. 36.

5. On *Potamon* (*Potamonautes*) *latidactylum*, a new Freshwater Crab from Upper Guinea. By Dr. J. G. DE MAN, of Ierseke, Holland.[1]

[Received November 15, 1902.]

(Plate IX.[2])

In the year 1881, *Potamon africanum* A. M.-E. was known only by the short diagnosis and the figures in the 'Nouvelles Archives du Muséum,'[3] made from a quite young individual from the Gaboon. The anterior legs had neither been described nor figured, and it is therefore not surprising that some older specimens of a *Potamon* from Liberia were referred by me erroneously to this species[4].

Some time since, three adult specimens of a *Potamon* were sent me for examination by Prof. Jeffrey Bell; they had been collected in the River Prah, in the south of Ashanti, West Africa. These Crabs not only proved to belong to the same species as that described by me in 1881, when compared with a female of medium size and a very young male from Liberia in the Leyden Museum, but they proved also to be new, as a typical specimen of *P. africanum*, a middle-sized female from "Ogoué" (evidently the River Ogowé, just below the Equator), was kindly sent me by Prof. Bouvier, and as a more complete description of *P. africanum* was published in 1887, in which, however, the legs have not been

[1] Communicated by F. JEFFREY BELL, F.Z.S.
[2] For explanation of the Plate, see p. 47.
[3] Vol. v. p. 186, pl. xi. fig. 2 (1869).
[4] *Telphusa africana* de Man, Notes Leyd. Mus. iii. p. 121 (1881).

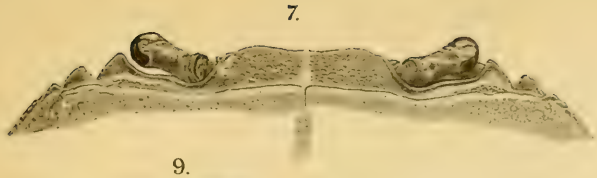
figured (A. Milne-Edwards, 'Observations sur les Crabes des eaux douces de l'Afrique,' Paris, 1887, p. 4, pl. 2. fig. 8). I therefore propose the name of *Potamon latidactylum* for this new species that inhabits Liberia and Ashanti, *on account of the characteristic shape of the hands*, and as this feature was not alluded to in my somewhat incomplete description of 1881, another will, I think, be welcome.

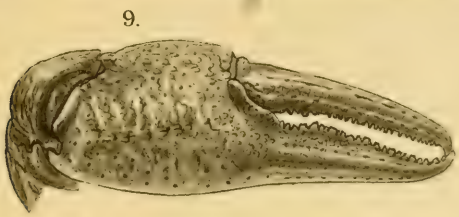
The rivers of West Africa and of the Soudan are inhabited by several species of *Potamon* which differ from the other species of this subgenus in the existence of *two* epibranchial teeth behind the external orbital angle, instead of one as is usual. I was at first inclined to create for these species a new subgenus, but the differences from *Parathelphusa* are, indeed, of too little importance. These species are the following:—

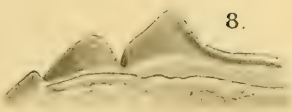
Potamon aubryi H. M.-E. Gaboon.
„ *pelii* Herklots. Gold Coast.
„ *africanum* A. M.-E. Gaboon; French Congo.
„ *decazei* A. M.-E. French Congo.
„ *emarginatum* Kingsley. West Africa.
„ *floweri* de M. Soudan.
„ *latidactylum*, n. sp. Upper Guinea.

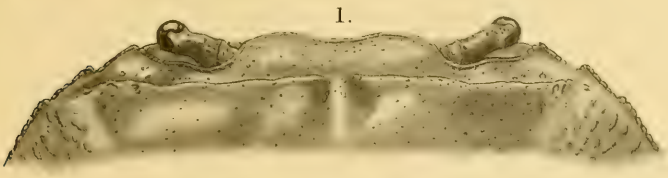
It must, however, be observed that *P. emarginatum* is considered by Miss Rathbun (Proc. U. S. National Museum, xxii. 1900, p. 283) to be the same as *P. aubryi*. *P. latidactylum* may at first sight be distinguished from *P. africanum by the different shape of the extraorbital and epibranchial teeth and by the different form of the hands, especially of the fingers*, but there are still other differences.

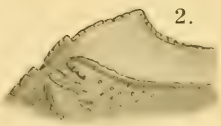
The cephalothorax is *a little more enlarged* than in the species from the "Ogoué," as is readily shown by the measurements. The upper surface is *somewhat less depressed*, the branchial regions are *somewhat swollen*, especially the anterior ones, and the gastric and cardiac areas are, in aged individuals, also *slightly convex* and not so much depressed as in *P. africanum*. The oblique furrows or depressions limiting off the protogastric areas from the anterior branchial lobes are scarcely distinguishable in *P. africanum*; in the other species, however, they are quite distinct, and, in adult individuals, *rather deep*. The urogastric lobes and the cardiac area are *a little broader* in proportion to the breadth of the carapace than in *P. africanum*. In the latter the gastric region is faintly granular or rugose just behind the postfrontal ridge, but in the new species it appears everywhere smooth, though finely and sparsely punctate. The anterior branchial area is slightly rugose in *P. africanum*, but not marked with oblique wrinkles; these are quite distinct in the species from the River Prah and Liberia; on the posterior branchial lobe these rugosities occur in both species, they are, however, thinner and finer in *P. latidactylum*. The posterior part of the upper surface

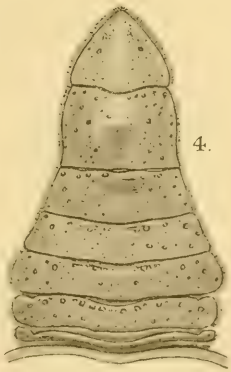












J. G. de Man del.

TAMON (POTAMONAUTES) LATIDACTYLUM.

FIG. 1-6

appears, on either side of the cardiac and intestinal regions, somewhat granular and rugose in the Congo species, but *quite smooth*, though finely punctate, in *P. latidactylum*.

In the large aged female from the River Prah the oblique rugæ near the lateral boundaries of the carapace show a tendency to disappear.

In both species the postfrontal ridge is *rather prominent, smooth*, and nowhere granulated. In the type specimen of *P. africanum* it extends in a nearly straight line towards the second epibranchial tooth, uniting with that of the right side, but ending about 1 mm. short of that on the left. The postfrontal ridge of *P. latidactylum* usually curves slightly forwards mesially and at each end; it *never unites* with the epibranchial teeth, ending about $1\frac{1}{2}$ or 2 mm. short of the middle of the first epibranchial tooth. It is situated a little more distant from the orbits than in *P. africanum*, so that the furrow behind the orbits is somewhat narrower in the latter species. The front has the same form and breadth in both, and shows in the middle *a broad, though shallow bay*; both the front and the furrow behind the orbits are a little granular in *P. africanum*, but *quite smooth*, though finely and sparsely punctate, in *P. latidactylum*.

The extraorbital and the two epibranchial teeth have *a quite different form* (Pl. IX. figs. 1–3 & 7, 8). In *P. africanum* (Pl. IX. figs. 7, 8) they are *more prominent* and separated from one another *by much deeper incisions*. The first epibranchial tooth is, in this species, a little smaller than the extraorbital, but has about the same form; its straight or slightly arcuate outer margin makes a right angle with the anterior margin of this tooth. In *P. latidactylum*, however, the extraorbital tooth and the anterior epibranchial one are *much less prominent* and *much lower*, the anterior margin of the first epibranchial tooth being *considerably shorter* than its outer margin, measuring only one-fifth of it. In the aged female from the River Prah the extraorbital tooth appears somewhat longer than the epibranchial one, and in the two males (Pl. IX. fig. 1) they have about the same length; in the much younger female from Liberia (Pl. IX. fig. 3) the epibranchial tooth, however, is almost twice as long as the extraorbital, but in the quite young male from the same locality (Pl. IX. fig. 2) the extraorbital tooth appears again once and a half as long as the epibranchial. As regards the relative length of these teeth, *P. latidactylum* presents therefore considerable individual differences. In both species the second epibranchial tooth passes backward into an arcuate crest, bounding the cephalothorax laterally; this crest, which in young individuals of *P. latidactylum* (Pl. IX. fig. 3) appears distinctly denticulate, the denticulations or crenulations disappearing in more aged individuals, reaches in *P. africanum to the posterior boundary of the urogastric lobes and does not curve inward* on to the surface of the branchial region: in *P. latidactylum*, however, it is *much shorter*,

scarcely reaching to the level of the mesial crescentic portion of the cervical suture, and *it distinctly curves inwards on to the upper surface of the carapace*. The orbits have the same form in both species, but in *P. africanum* the incision that separates the extraorbital tooth from their lower margin is *deep*, much deeper than in the new species, so that in the former the outer angle of the orbits strongly projects beyond this margin.

In *P. africanum* the transverse furrow, limiting off the subhepatic region from the branchial floor, is bordered by a row of small granules, the subhepatic area is covered with prominent rugosities and granules; in our new species the latter appears almost smooth, and the row of granules is also less distinct. The rugosities on the inflected portion of the cephalothorax and on the outer part of the pterygostomian regions are also much less distinct in the species from Upper Guinea than in *P. africanum*.

The outer foot-jaws have the same form and characters in both species, and the furrow on the ischium-joint runs in both *a little* closer to the internal than to the outer margin of this joint.

The type of *P. africanum* is a female, the abdomen of which has not yet obtained its full development and size. The sternum of *P. latidactylum* is smooth, punctate, and in both species a transverse furrow unites the postero-external angles of the buccal frame. The male abdomen (Pl. IX. fig. 4) somewhat resembles that of *P. consobrinum* de M. (Notes Leyden Museum, 1899, pl. 10. fig. 10, *i*). The lateral margins are slightly concave. The terminal joint has about the same length as the penultimate; it is triangular, rather pointed at the tip, not rounded like that of *P. consobrinum*; the lateral margins are very slightly arcuate posteriorly, nearly straight towards the tip. The posterior margin of the penultimate joint is a little broader than the anterior; the lateral margins, slightly convex anteriorly, are a little concave posteriorly. The length of the antepenultimate joint measures about two-thirds that of the penultimate, its posterior margin is a little concave, so that the lateral margins are somewhat shorter than the length of this joint in the middle line. The lateral margins of this and of the following fourth joint are straight, but those of the fifth are rounded; in *P. consobrinum*, however, this latter is also straight. As regards the coarse punctation, *P. latidactylum* agrees with *P. consobrinum*.

In the two males from the River Prah the right chelipede is a little larger than the left; in the very young one from Liberia the left is a little larger. The upper margin of the arm of the larger male from the River Prah bears some transverse rugosities, and one observes a small tubercle on the concave upper surface at the proximal end, somewhat nearer to the upper than to the anterior margin; the latter is also somewhat tubercular on its proximal half. The anterior surface of the arm bears, near the articulation of the wrist, a conical tubercle not far from the anterior margin, and a lower, broader tubercle between it and

the under margin; the latter is also slightly tubercular along its distal half. The three faces of the arm are quite smooth. The carpus is also nearly smooth above, though sparsely and rather finely punctate; the inner margin is armed with a rather small pointed spine in the middle and beneath it with a small acute tubercle. The larger chela (Pl. IX. fig. 5), measured horizontally, is a little longer than the length of the cephalothorax and the fingers are a little longer than the palm; the latter is just *as long as high* near the articulation of the fingers. The convex outer surface of the palm is quite smooth, though finely punctate, similar to the upper margin, but the lower edge of the palm is obsoletely tubercular. The fingers are *somewhat compressed, especially the immobile one. The immobile finger is rather high at the base;* its *flattened* outer surface appears *minutely and densely granular* under an ordinary lens, and one observes on it three longitudinal rows of impressed points running to the tip of the finger, the middle one of which is situated a little closer to the lower margin of the finger than to the upper, and looks like a very shallow furrow. The 15 or 16 teeth are small, two or three are somewhat larger than the others, and one in the middle of the finger is the largest of all. The fingers leave a narrow interspace between them when closed, the pointed tips being only in contact and crossing one another. The dactylus is somewhat arcuate and tapers rather slowly to the tip; both on the outer and inner surfaces and on its upper edge this finger appears *minutely granular* under a lens, and one observes on it several rows of small shallow puncta. The teeth agree in size and in number with those of the index, three or four being somewhat larger than the others. The little convex inner surface of the palm is quite smooth.

The left chelipede is somewhat smaller, the hand being 41 mm. long; it fully agrees with the right one, but the fingers are in contact and the rows of puncta are a little more distinct.

In the young male from Liberia the fingers are in contact in both chelæ, the upper margin of the palm appears distinctly granulate under a lens, and the longitudinal furrows on the fingers are already visible to the naked eye.

In the young female from Liberia the right chelipede is a little larger than the left, the fingers are in contact, and the furrows on the index, as also the rows of puncta on the mobile finger, are distinctly visible to the naked eye. The upper margin of the palm of the left hand appears finely granular.

In the aged female from the River Prah the left chelipede is *much larger than the right*; the hand, indeed, is 45 mm. long, just as long as the cephalothorax, and 20½ mm. high, but the right chela (Pl. IX. fig. 6) is only 31 mm. long and 13 mm. high. In both the fingers are in contact throughout their whole length and the pointed tips cross one another; *the strongly compressed and much flattened immobile finger* is not furrowed, though the

rows of puncta are still visible. The fingers are but little longer than the palm, and the latter is on its outer surface and on its upper margin smooth, sparsely punctate. The fingers of the smaller chela, however, are *once and a half* as long as the palm (Pl. IX. fig. 6).

The female type-specimen of *P. africanum* compared with the female from Liberia, which is about the same size, shows the following differences:—The anterior legs (Pl. IX. fig. 9) are *equal*, as regards their shape and size. The transverse rugosities on the upper margin of the arm are more distinctly granular, and the anterior and lower margins are also more distinctly tuberculated; the conical spine on the anterior surface, near the articulation of the wrist, is more pointed, and several small tubercles are seen between it and the anterior margin of the arm, that are wanting in *P. latidactylum*. The upper surface of the carpus is slightly granular at the base of the spine on the inner margin, and one observes, moreover, everywhere fine impressed lines and points; the spine is somewhat larger than in *P. latidactylum*, and instead of a small tubercle, there is beneath it a smaller, pointed spine. The hands (Pl. IX. fig. 9) have *a quite different form*. The fingers, almost in contact, are *distinctly somewhat longer than the palm*, and *the latter is distinctly less high than long*. The upper margin of the palm is covered with depressed granules, and the puncta on the convex outer surface are partly arranged in longitudinal rows. The fingers are *not compressed*, *slender*, *nor curved*, except at the pointed tips which cross one another. The immobile finger is *much lower* at its base than in the other species, and its *convex* outer surface is *distinctly furrowed*; of the three furrows visible to the naked eye, the middle one is deeper than the others. This finger is armed with 25 or 26 small teeth, some of them on the proximal half are somewhat larger than the others. Finally, the dactylus tapers regularly to the tip and is also longitudinally furrowed by rows of impressed points; the teeth agree with those of the index. The fingers are almost smooth.

The ambulatory legs, the measurements of which are given on p. 47, apparently agree with those of *P. latidactylum*, but the meropodites are *more granular along and near their upper edges*.

Potamon aubryi H. M.-E., from the Gaboon, *P. pelii* Herklots, from the Gold Coast, and *P. floweri* de M., from the Soudan, are different species (*vide* de Man, Proc. Zool. Soc. Lond. 1901, vol. i. p. 94), being at first sight distinguished by the upper surface of their cephalothorax being *very convex* from behind forwards, *smooth* and *shining*, *by the different form of the fingers*, *of the abdomen*, &c. The young male of *Potamon pelii* described *l. c.* p. 99, I have re-examined for the purposes of this memoir.

Measurements in millimetres.

	1. ♀.	2. ♂.	3. ♂.	4. ♀.	5. ♂.	6. ♀.
Breadth of the cephalothorax	67	58	51	48½	34½	53
Length of the cephalothorax without the abdomen	45½	39	35	33	24⅗	39
Distance between the external orbital angles	40½	35½	31	30½	23	32
„ „ posterior epibranchial teeth	57½	50	43½	42½	31½	43½
Breadth of the anterior margin of the front	18	16	14	14	10½	14
Distance, in the median line, between the anterior margin of the front and the postfrontal ridge	6	5	4½	4	3¼	4½
Distance between the outer angle of the orbits and the postfrontal ridge	5½	4½	4½	4	3⅕	3½
Distance between the outer angle of the orbits and the posterior epibranchial tooth	10	8½	6¾	7½	5¼	6½
Breadth of the urogastric areæ	11	8½	7	6½	4¼	7
„ „ cardiac areæ	17	12	10½	10	7½	9
„ „ orbits	11	9½	8¼	8	6¼	8½
Height of the orbits, near the lower internal angles	6	5⅝	5	5¼	3⅝	6
Length of the terminal segment of the abdomen	...	7	5¾	...	4½	
„ „ penultimate segment	...	6½	6	...	4½	
Breadth of the anterior margin of this segment	...	8¼	7¾	...	5¼	
„ „ posterior margin of it	...	10½	9	...	6⅖	
Length of the larger chela	45	46	39	31½	22½	34
„ „ palm	21	22½	19½	16	11	16
Height of the palm, near the articulation of the dactylus	20½	22½	19½	15½	11	13
Length of the legs of the penultimate pair	86	76	71	66	50	80
„ „ meropodites of the penultimate pair	27	25	23½	21	16½	27
Breadth „ „ „ „ „	8½	8½	7¾	8	6⅕	8½
Length of the propodites „ „ „	15	13	12½	12	9½	15½
Breadth „ „ „ „ „	6½	6	5½	5½	4	6¼
Length of the dactylopodites „ „ „	20½	17	15½	15½	11½	18
„ „ legs of the last pair	72	61	57	51	39	60
„ „ meropodites of the last pair	21½	19½	18	16¼	13	20
Breadth „ „ „ „	8	7½	7	7	5½	8
Length of the propodites „ „	11½	10½	9¾	9½	7	12
Breadth „ „ „ „	7	6½	6	6	4½	7¼
Length of the dactylopodites „ „	17	12½	11	10½	8	11½

Nos. 1–3, River Prah; Nos. 4, 5, Liberia; No. 6, type-specimen of *Thelphusa africana* A. M.-E., Ogoué, from the Paris Natural History Museum.

EXPLANATION OF PLATE IX.

Figs. 1–6. *Potamon (Potamonautes) latidactylum*, n. sp.—Fig. 1. Dorsal view of the anterior part of the carapace of the largest male specimen from the River Prah, × 1½. Fig. 2. Left antero-external angle of the carapace of the young male from Liberia, × 3. Fig. 3. The same of the young female from Liberia, × 3. Fig. 4. Abdomen of the largest male from the River Prah, × 1½. Fig. 5. Larger chela of the same male from the River Prah, × 1½. Fig. 6. Smaller chela and carpus of the adult female from the River Prah, × 1½.

Figs. 7–9. *Potamon (Potamonautes) africanum* A. M.-E., female type-specimen of the Paris Museum, from Ogoué.—Fig. 7. Dorsal view of the anterior part of the cephalothorax, × 1½. Fig. 8. Left antero-external angle of the carapace, × 3. Fig. 9. Right chelipede, × 1½.

6. On a new "Bird's-dung" Spider from Ceylon. By R. I. Pocock, F.Z.S., and the Hon. N. C. Rothschild, B.A., F.E.S., F.Z.S.

[Received November 18, 1902.]

(Plate X.[1])

During a recent visit to Ceylon, the Hon. N. C. Rothschild, in company with Mr. E. E. Green, discovered a specimen of a Spider (*Phrynarachne*) imitating, for purposes of allurement and concealment, a patch of bird's-dung. A photograph of the spider resting upon the leaf *in situ* was obtained, and the leaf with its patch of web was brought home with the spider (Pl. X. figs. 1, 2).

The film of white web upon the leaf, with its irregular outline and marginal, often apically thickened projections, closely assimilates the splash of the fluid components of the excrement; while the spider itself, with its mottling of black and white, resting upon the centre of the film, with its legs tucked in, represents the semi-solid central core. So close, indeed, was the imitation that both observers were for a time deceived, until closer scrutiny revealed the true nature of the deceptive patch.

It is commonly assumed that the purpose of this imitation is purely alluring or pseudepisematic. No doubt, however, it is an equally important procryptic factor, serving to protect the spider from various enemies, especially the wasps of the family Pompilidæ.

The spider, which appears to represent an undescribed species, may be named after one of its discoverers[2].

Phrynarachne rothschildi, sp. n.

♀.—*Colour*. Carapace with a broad central black patch, with irregular lateral margin, extending from the eyes to the posterior slope, and forming an angular expansion on each side immediately behind the head; and with its posterior border passing into a median longitudinal stripe, continuous with a transversely arcuate black stripe which extends from the middle of the posterior slope of the carapace on to its lateral portion, breaking up into fainter patches separated by radiating pale bands; clypeus, sides of head, and area between central patch and lateral patches yellowish white. Mandibles yellow in basal half, with a large black patch, not reaching the fang, in the distal half in front, blackish brown beneath. Sternum mostly yellowish white, with a large subtriangular black patch, divided by a narrow pale line in its posterior half, and some black at the bases of the legs. Labium blackish, maxillæ blackish internally, whitish externally. Palp with its femur white below, black above in its basal half; patella white, tibia and tarsus black, variegated with yellow patches. First and second legs with the coxæ black, variegated

[1] For explanation of the Plate, see p. 51.

[2] Mr. R. I. Pocock takes the sole responsibility for the naming and description of the species.

F. Pickard-Cambridge del. et lith.

West, Newman imp

PHRYNARACHNE ROTHSCHILDI.

with dirty yellow below, whitish with a black spot above; femora jet-black variegated with paler patches above, in front, and behind, with a narrow whitish line between the tubercles below, the distal end yellowish white; patellæ yellowish white, with two palely fuscous patches above and some behind; tibiæ and protarsi mostly jet-black, with a pale median inferior longitudinal stripe between the spines; tarsi pale above, black below; third leg with coxa and trochanter blackish below, the femur amber-yellow in its basal two-thirds, yellowish white with a black patch, much broader behind than in front, in its distal third; tibia black and whitish, the black predominating posteriorly; protarsus and tarsus mostly yellowish; fourth leg, with exception of its coxa, mostly yellowish white, lightly spotted above. Almost the whole of the upperside of the abdomen jet-black from its anterior margin backwards to the spinners, with the postero-lateral tubercles and the sides yellow; the under surface (*i. e.* the area between the lung-sacs on the epigastric region and behind the genital fold nearly back to the spinners) black, this black field showing a transversely oblong pale patch behind the genital aperture (Plate X. figs. 3 & 4).

Carapace not strongly tubercular, flattish longitudinally along the middle line, with a shallow transverse depression behind the ocular area of the head; area between the ocular tubercles depressed; eyes of posterior line (fig. 5) subequally spaced, the medians about 5 diameters apart, lying about their own diameter in front of a tangent joining the anterior borders of the laterals, which are distinctly larger than the medians; eyes of anterior line (fig. 6) strongly recurved, the inferior edges of the laterals as high as the superior edges of the medians, the latter considerably smaller than the laterals, about $2\frac{1}{2}$ diameters from each other and about 2 diameters from the laterals[1]; distance between the medians about equal to the height of either above the edge of the clypeus, which is weakly tubercular and furnished with prominent angles.

Mandibles prominent basally, scarcely tubercular; margins of fang-groove thickly fringed, the posterior armed with one fang, the anterior with teeth, remote from base of fang; the posterior fringe continuous with a scanty band of hair passing up the inner side of the posterior surface of the mandible.

Legs. Femur of 1st leg thickly covered in front with small tubercles, with a few large tubercles above and two rows of about five tubercles each below, the posterior surface smooth; tibia bowed, armed beneath with two rows of about 4–5 spines, the anterior and dorsal surface also spined; protarsus a little longer than tibia, armed beneath on each side of the middle line with a band of longer and shorter irregularly arranged spines, those on

[1] Owing to a want of definition of the border of the corneal lens, the precise size of the eyes of the anterior line, and consequently of the width of the interspace between them, is hard to ascertain, varying apparently in different lights and with lenses of different power. In the above-given description the eyes are described as seen under a 4-inch objective and a platyscopic lens.

the posterior side being much less numerous than on the anterior, the anterior and dorsal surfaces of the segment also spiny; tarsus covered with rows of spinules; 2nd leg like the 1st, but with the femur almost quite smooth; 3rd and 4th legs with tarsi bristly beneath, tibia of 3rd spined below, of 4th scarcely spined.

Abdomen as wide behind as it is long, and twice as wide as it is in front, the anterior border transverse and armed with four tubercles, the lateral border with four small tubercles, the postero-lateral angle with two large superior and two small inferior pale tubercles; between the former are four pairs of shining black tubercles, two pairs of which are much larger than the others; in addition to these the dorsal surface is furnished with three pairs of small scattered tubercles; lateral surface pitted; inferior surface with two rows of muscular pits. *Vulva* undeveloped.

Measurements in mm.—Total length 9, carapace 4; posterior width of abdomen 5·5, anterior width nearly 3; length of 1st leg 14, its femur 4, patella + tibia about 5, 3rd leg 6, tarsus + protarsus about 5.

Loc. Kandy.

In size and shape this species does not appear to differ appreciably from *P. ceylonica* O. P. Cambridge (P. Z. S. 1884, p. 201, pl. xv. fig. 3, sub *Ornithoscatoides*), which was recorded from Ceylon. The colouring of the two, however, is very different. In *P. ceylonica* the anterior legs are heavily blackened only upon the protarsi and distal half of the tibiæ, the mandibles have no black patch, and the black-and-yellow pattern of the carapace and abdomen, so conspicuous in *P. rothschildi*, is but little differentiated; also the cephalic tubercles between the two rows of eyes are much higher in *P. ceylonica* (see also Simon, Hist. Nat. Araign. i. p. 1043, fig. 1087, 1895).

Another Ceylonese species, *O. nigra* O. P. Cambr. (*loc. cit.* p. 202, pl. xv. fig. 4), was based upon the male sex, and cannot, therefore, be compared with those based upon females. A third species, *P. fatalis* O. P. Cambr. (P. Z. S. 1899, p. 525, pl. xxx. fig. 7), from Ceylon, differs so markedly in form, coloration, tuberculation, &c., as to need no comparison with this new species. Also *P. peeliana* Stol. (J. A. S. Bengal, xxxviii. 1869, p. 229, pl. xx. fig. 4), from Sibsagar, Assam; *P. tuberosa* Blckw. (Ann. Mag. N. Hist. (3) xiv. p. 38, 1864, & P. Z. S. 1884, pl. xv. fig. 2), from the East Indies; and the Burmese form *P. papulata* Thorell, are all different from this new form.

To Dr. H. O. Forbes, F.Z.S.[1], belongs the credit of the discovery that the coloration of the species of *Phrynarachne* belongs to the pseudepisematic category. The pattern of yellow and black which decorates the dorsal and ventral sides simulates that of the semi-solid central portion of a patch of bird's-dung splashed upon a leaf, the paler more fluid portion being represented by a thin irregular-shaped carpet of white silk, in the centre of which the spider takes its stand. The spider discovered by Messrs. Rothschild

[1] P. Z. S. 1883, p. 586, pl. li.

and Green was resting upon the leaf in the normal position, that is to say back uppermost (figs. 1 & 2).

Forbes, however, expressly states that *P. decipiens*, the species he discovered, lies back downwards on the web, holding itself in place by means of the spines with which the anterior upper surfaces of the legs are furnished, and he adds that the underside of "its rather irregularly-shaped and prominent abdomen is almost all white, of a pure chalky white" (p. 587), and that "its pure white abdomen represents the central mass of the bird's excreta, the black legs the dark portion of the slime." Reference, however, to his figure, which was apparently drawn partly from memory, the leaf and web having "gone astray" during the transport home, shows that the underside of the abdomen, so far from being almost all white, is furnished with a large black sub-oblong patch, which extends from its anterior border considerably past the middle. It is noticeable, too, that from the ventral aspect the abdomen is not irregularly shaped, but evenly oval in outline and devoid of tubercular excrescences. The dorsal surface, on the contrary, as represented in the figure given by Mr. Cambridge (P. Z. S. 1884, pl. xv. fig. 1), might very well be described as almost all white and rather irregularly shaped. The white colour largely predominates, and the tubercles project prominently from the expanded posterior portion. Mention is made of these discrepancies between the figure and description, to justify the suspicion that Dr. Forbes may have mistaken the dorsal for the ventral surface of the spiders he saw. Moreover, one cannot but wonder how the spider maintains a secure hold back downwards, especially when the powerful prehensorial legs of the first and second pairs are released, as released they must surely be, to seize an alighting butterfly. One would think that the flapping of the insect's wing would pull the spider, now insecurely anchored, from its hold and bring both to the ground together. On the other hand, if the spiders of this kind always rest in the normal position seen and photographed in the case of *P. rothschildi*, the simulation of the bird's-dung is equally perfect, and the spider, while seizing a butterfly with its fore legs, can maintain itself securely in place by grasping the web with the claws of the remaining pairs and by gluing its spinning-mamillæ to the subjacent silken threads.

These, then, are the points for further investigation which we would ask residents in the tropics to take note of:—Do the species of *Phrynarachne* assume indifferently the dorsal or the ventral attitude? Is it a peculiarity of one species to lie back uppermost, and of another belly uppermost? If they lie, as Forbes asserts, back downwards, how is a secure hold maintained when an insect has to be seized?

EXPLANATION OF PLATE X.

Phrynarachne rothschildi, sp. n., p. 48.

Figs. 1, 2. The Spider resting on leaf. Fig. 3. Upper surface. Fig. 4. Under surface. Figs. 5, 6. Eyes.

7. On the Crustaceans of the Genera *Petalidium* and *Sergestes* from the 'Challenger,' with an Account of Luminous Organs in *Sergestes challengeri*, n. sp. By Dr. H. J. Hansen (Copenhagen).

[Received November 29, 1902.]

(Plates XI. & XII.[1])

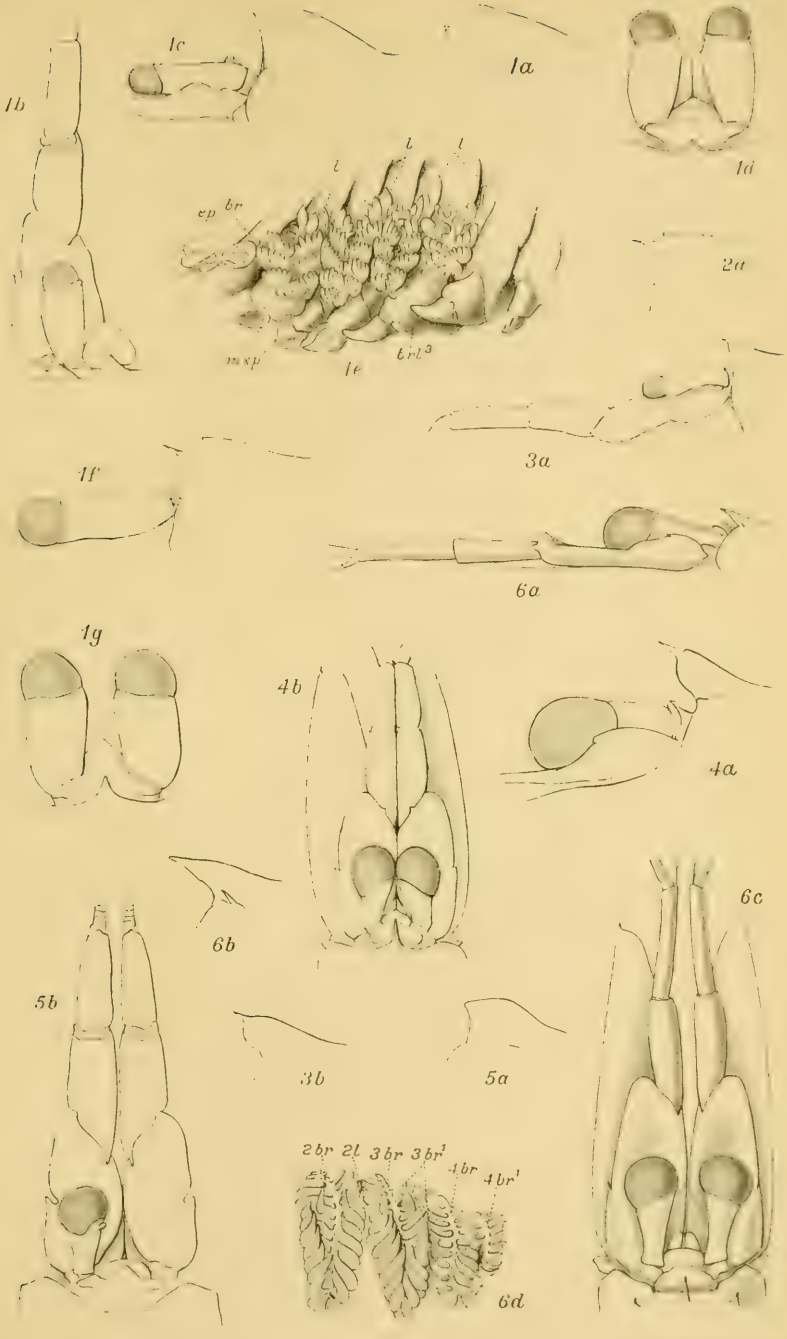
During a stay in London in July and August, 1902, I examined various groups of Crustacea in the British Museum (Natural History). I beg the Director, Professor E. Ray Lankester, and Mr. F. Jeffrey Bell to accept my sincere thanks for the free use of the collection and for their kind help.

In the paper "On the Development and the Species of the Crustaceans of the Genus *Sergestes*" (Proc. Zool. Soc. Lond. 1896, pp. 936–70) I have given a revision of this extensive genus. I had studied a very rich material of pelagic forms belonging to the Copenhagen Museum, among which are all the types of Kröyer; besides I had examined types of 5 species established by Chun, Metzger, and Ortmann.

Among other things, I proved that "*of the* 59 (*or* 60) *hitherto described species only about* 20, *or one-third of the total number, have been established on adult animals, such as have almost or entirely arrived at sexual maturity; and that almost all the other species are true larvæ, and even of these a considerable number are larval stages of species already established on adult specimens, . . .*" Of earlier authors, C. Spence Bate has produced a very large contribution on the genus *Sergestes*, extending to eighty-eight quarto pages and seventeen plates, in his "Report on the 'Challenger' Macrura." He established the genus *Petalidium* on a new species, described 24 new species of *Sergestes* &c. In 1896 I wrote (p. 939): "This large contribution is of course of great importance, but unfortunately neither the descriptions nor the figures are so good as could be wished, and in numerous instances . . . a re-examination of the type specimens is absolutely necessary —the greater part of the new species are but larvæ." I have now studied all types which are preserved in the British Museum, and the present paper contains the results of my examination.

Bate describes 31 species of *Sergestes* as examined by himself: of these, 24 are established as new to science, 6 are considered to be Kröyerian species, and one is referred to *S. atlanticus* H. M.-Edw. The types of 9 of the species established by Bate do not exist in the British Museum; some specimens mentioned in his work and belonging to other species are also absent; but several specimens belonging to various species and omitted in the Report were found in the collection. I am therefore only able to give more or less incomplete notes, based on the study of the

[1] For explanation of the Plates, see p. 78.



H. J. Hansen del.

Edwin Wilson, Cambridge

FIG. 1. PETALIDIUM FOLIACEUM. 2. PETALIDIUM JUN. 3. SERGESTES PROFUNDUS. 4. S. PREHENSILIS. 5. S. KRÖYERI. 6. S. SIMILIS.

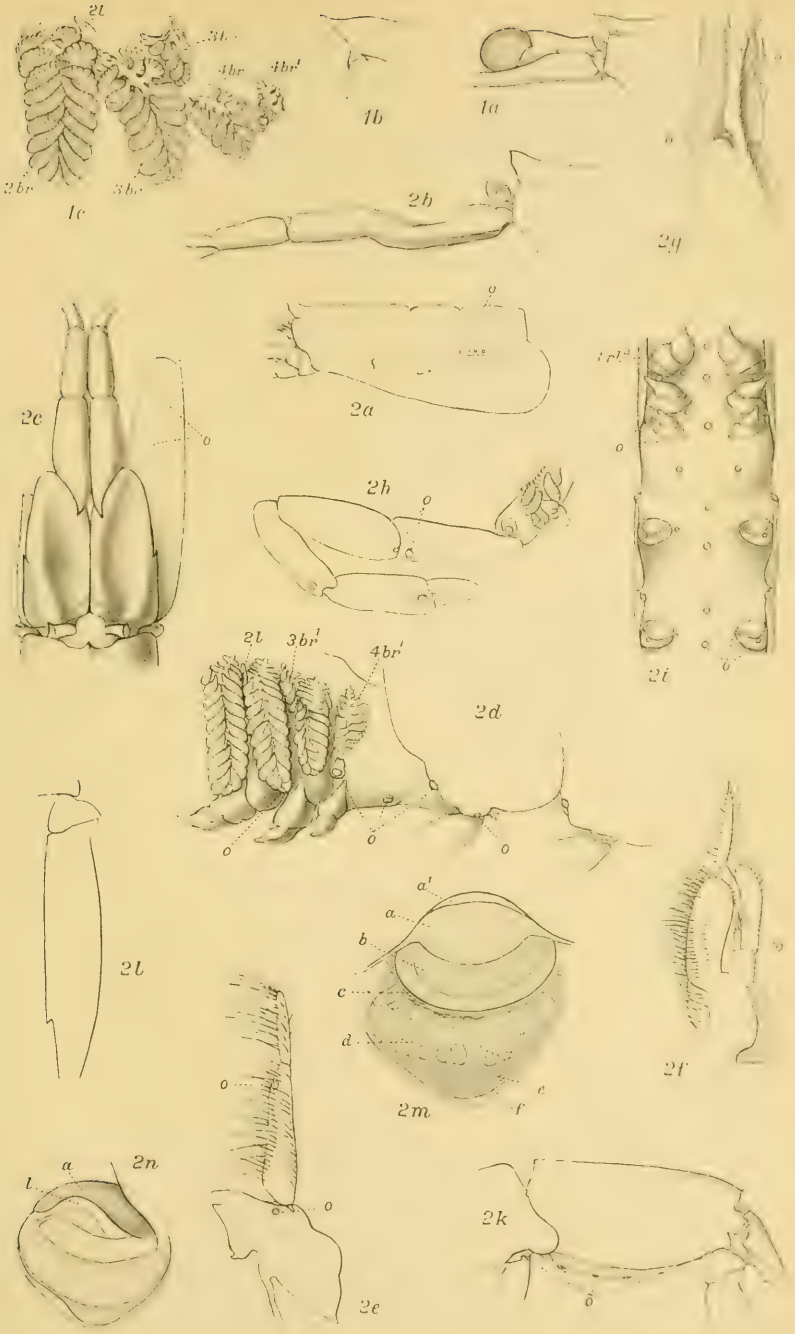


FIG.1.SERGESTES ARCTICUS. 2.S.CHALLENGERI.

specimens, on 22 of the species in question, 15 of which were established by Bate himself. Furthermore, he refers *Petalidium* Bate, *Sciacaris* Bate, *Acetes* H. M.-Edw., and *Lucifer* Vaugh. Thomps. to his family Sergestidæ; of *Lucifer* he describes two species, but the genus must be more thoroughly studied than has hitherto been done before the examination of the 'Challenger' specimens; *Sciacaris* Bate has one species, which is only a larva of a *Sergestes*, and the type seemed to be wanting in the Museum; of *Acetes*, Bate had no specimens; and *Petalidium* is mentioned below.

Of Bate's 31 species of *Sergestes* only 6 are really mature forms, 25 being larvæ. Special attention has been paid to the adult specimens preserved in the Museum and enumerated by Bate; on two of these specimens I have established two new species, and besides I add notes and some drawings to the representations of Bate. Unfortunately nearly all the specimens of rare and especially interesting species were very much mutilated.

Our present knowledge of the adult species of *Sergestes* of the Atlantic fauna is far from complete, but yet we are acquainted with so many species that it was possible for me in my earlier paper either to refer the *Mastigopus*-forms examined to the mature species, or to describe the older larval stages and sometimes the black-eyed but still immature forms, so that they can be recognized with certainty and referred to the mature forms when these are discovered in the future. All the Atlantic larval forms from the 'Challenger' seen by me have now been referred in a similar way. But many larvæ established by Bate as valid species of adult or sub-adult animals have been secured in the Pacific. Our knowledge of the mature stage of the species living in that vast ocean is still rudimentary; and I have therefore not been able to refer the larvæ of three of Bate's species to any species established on adult specimens. Bate's types of his species established on larval forms are often either defective or very young, wherefore I thought it of little use to describe and figure them again; but I have generally added some notes on their affinities, and sometimes also a few corrections to his descriptions. When the Pacific has been moderately well explored by further expeditions, many adult forms and their larval stages will be discovered; and a future student of the group will then be able to refer at least some of the larvæ, which I cannot interpret, to their adult forms. To the young larvæ described by Bate as species of *Mastigopus* I pay no attention at all: the types seem to be lost.

I think it convenient first to deal with all the 'Challenger' species in the same consecutive order in which they are described in Bate's Report; then to put together some results of the investigation; finally, to mention more fully the luminous organs in *Sergestes challengeri*, n. sp.

In order to abridge the descriptions, in the following pages—as in my earlier paper—I make use of some abbreviations:—

antenn. ped. = peduncle of the antennulæ; mxp.^{2}–mxp.^{3} = the second and third pair of maxillipeds; trl.^{1}–trl.^{5} = the first to the fifth pair of trunk-legs; br. = the first, br.^{1} = the second branchia above the same legs; ext. br. of urp. = external branch of the uropods.

I. *Notes on the Species of* Petalidium *and* Sergestes.

a. Petalidium Bate.

To this genus Bate has referred only one species. It will be convenient to deal with the characters of the genus together with those of the species.

Pet. foliaceum Bate, pp. 348–50, pl. lx. (Plate XI. figs. 1*a*–1*g*.)

Bate mentions five specimens from two stations: Stat. 146, lat. 46° 46′ S., long. 45° 31′ E., 1375 fathoms; and Stat. 159, lat. 47° 25′ S., long. 130° 22′ E., 2150 fathoms. All these specimens are at present in the Museum, but even Bate's text and his figure of the entire animal show that most of the appendages presenting specific characters are wanting or have been mutilated. Bate writes (p. 349): "The great distinction between this genus and *Sergestes* exists in the form, character, and arrangement of the branchial plumes, which consist of a series of plates and cylindrical filaments, situated side by side in a series of rows at right angles to the stalk. There is but one plume to each of the five anterior somites of the pereion, the posterior two somites having none; between some of the somites is a large foliaceous plate." But this description is difficult to understand: his figure 3, representing the branchiæ, is defective, and his tabular view (p. 349) is wrong. He was of opinion that the foliaceous plates—of which he had seen only three—were pleurobranchiæ, while the "branchial plumes" were arthrobranchiæ; but this is incorrect: they are decidedly pleurobranchiæ as in *Sergestes*. *Petal. foliaceum* Bate differs from all species of *Sergestes* in one quite unimportant feature, that no trace of branchiæ is found above trl.^{4}, and in one important character, viz., the structure of the pleurobranchial plumes. This structure is very interesting (fig. 1 *e*). The most developed branchiæ are, as usual, those above trl.^{1} and trl.^{2}; each of these consists of an anterior and a posterior half, and each half of five (to six) transverse rows of branchial plates, generally five or six in each row, and these plates (some of the lowest excepted) are directed upwards. The pleurobranchiæ above mxp.^{3} and especially trl.^{3} are less developed, with a lower number of transverse rows, and partially with a lower number of plates in the rows. The pleurobranchial plumes in *Petalidium* look very different from those in *Sergestes*; the real differences are: a much lower number of rows, a much lower number of plates in the rows, and that the plates are much larger, curved upwards, and look much more independent. Behind the upper part of each of these four pleurobranchiæ originates a pleurobranchial lamella (*l.*),

which is a reduced branchia; these lamellæ are very long above trl.[2] and trl.[3], while the two anterior lamellæ above mxp.[3] and trl.[1] are much less prominent. On mxp.[2] is found an epipod (*ep.*), with a branchia consisting of a few plates, and above it a rudimentary pleurobranchia consisting of one very small lamella.

Fig. 1 *a* and fig. 1 *c* show the rostrum, consisting of a carina with a short or very short terminal spiniform process. There are no supraocular or hepatic spines; the gastro-hepatic groove is well developed. A comparison of fig. 1 *c* with fig. 1 *d* shows that the eye-stalks are considerably depressed; they are from two and a half to nearly three times longer than the eyes at the inner terminal angle, with a small rounded knot turning inwards and a little upwards (fig. 1 *b*; fig. 1 *d*), and besides (always ?) with an exceedingly small tubercle somewhat in front of the inner angle and more downwards on the inner side (fig. 1 *d*). In the antenn. ped. the basal joint is very broad (fig. 1 *b*), decidedly shorter than the outer margin of the two other joints together; the third joint is scarcely three times longer than broad, considerably longer than the outer margin and a little shorter than the inner margin of the second joint, which is stout, with its inner margin only a little more than twice as long as its breadth. (The specimen from which figs. 1 *c* and 1 *e* were drawn measures 51 mm. in length, and was captured on Stat. 146; figs. 1 *a*–1 *b* were drawn from the specimen secured on Stat. 159).

But besides these five specimens of *Petalidium*, I found still two smaller specimens of the same genus among the 'Challenger' animals. One of these had been determined as *Sergestes japonicus* Bate, but is not referred to that species in his text. It was captured at Stat. 158, 7/III., 1874, 1800 fathoms, thus near one of the above-named stations. It measures only 21·5 mm. in length. Figs. 1 *f* and 1 *g* show that its rostrum has the terminal process somewhat longer than in the large specimens; the eyes are a little longer as compared with the length of their stalks, and these are proportionately somewhat broader, without a distinct knot at the end of the inner margin. There is no supra-ocular spine, but the hepatic spine is moderately developed; the gastro-hepatic groove is very distinct. No branchiæ above trl.[4] This small specimen belongs certainly to *P. foliaceum* Bate.

Bate established (pp. 428–31) his *Sergestes profundus* on two specimens, both badly mutilated. He describes each specimen separately, beginning with one captured at Stat. 137, lat. 35° 59′ S., long. 1° 34′ E., depth 2550 fathoms. But, unfortunately, this specimen does not belong to *Sergestes* but to *Petalidium*; the type is besides so mutilated that I should have preferred to omit it, if it had not been described by Bate. It measures 17·5 mm. in length. The rostrum is shown in fig. 2 *a*; it is described by Bate: "It consists of a short fine point projecting horizontally for about one-fourth the length of the ophthalmopod, and is dorsally furnished on the crest with a small tooth." The eye-stalks are as in the small specimen from Stat. 158 just

described; the posterior branchiæ to a large degree are destroyed, and as to the other features, I refer to Bate's description (p. 429). I cannot say with certainty whether the animal is a very young specimen of *P. foliaceum* Bate, or belongs to an unknown form; the rostrum deviates considerably from the type of *P. foliaceum*, but its shape presents a stage between those in the adult and in a larva, nearly agreeing with that in a larval form mentioned below.

In my earlier paper on *Sergestes* I described *S. obesus* Kr. (=*S. sanguineus* Chun). I stated that it was a larva, a *Mastigopus*, and added (p. 968): "It is easily seen that this species cannot remain in the genus *Sergestes*, but whether it should be referred to *Petalidium* Bate, or a new genus should be established for its reception, is impossible to decide with certainty. The branchial plates recall the plates found in *Petalidium*, and therefore I provisionally transfer it to that genus. . . ." I had not seen any adult *Petalidium*, but suggested (p. 967) that the branchial plumes interpreted by Bate as arthrobranchiæ are in reality pleurobranchiæ. I can now decide that *S. obesus* Kr. is the *Mastigopus* of *Petalidium*: the branchiæ prove it; besides, trl.[3] in the *Mastigopus* is exceedingly elongate, with the basal part very thick, and in the adult form the basal joint of the same pair (fig. 1 *e*) is exceedingly thick, very much thicker than those of trl.[1] and trl.[2]. Finally, the shape of the rostrum of *S. obesus* Kr. agrees nearly with that of the young *Petalidium* from Stat. 137 just mentioned. I described the branchiæ of *S. obesus* Kr., stating that in the largest specimen a rudimentary branchia was found above trl.[4]; in the largest but one of the specimens I have now looked for this branchia, and found it. Finally, I stated that *P. obesum* (Kr.) is "decidedly distinct from *P. foliaceum* Bate," and I maintain this opinion, founding it on the fact that *P. foliaceum* does not possess any branchia above trl.[4]; and it is very improbable that such a branchia begins to develop itself in the *Mastigopus* and disappears again in the adult.

b. Sergestes H. M.-Edw.

Serg. intermedius Bate, p. 383 (no figure).

Bate mentions one specimen, 5 mm. in length, from the "China Sea, off Luzon." The specimen has been preserved; according to the rostrum, the eye-stalks, and the ext. br. of urp., it belongs to "*Serg. brachyorrhos* Kr.," which is the youngest *Mastigopus* of *S. edwardsii* Kr. (P. Z. S. 1896, pp. 963–64).

Serg. prehensilis Bate, p. 385, pl. lxxi. (Plate XI. figs. 4 *a*, 4 *b*.)

Bate has examined one specimen from Stat. 236, lat. 34° 58′ N., long. 139° 29′ E., off Japan, 775 fathoms. The type, an adult male, has been preserved; it differs from all other species known to me. It will be useful to redescribe its most essential characters, and two new figures are given (Pl. XI. figs. 4 *a*, 4 *b*). The

rostrum is rather long, directed forwards and considerably upwards; its terminal portion is produced into a spiniform process, and the upper margin of the rostrum has at the base of that process a sharp angle as a rudiment of a spine; the lower margin of the rostrum between its base and the apical spine is strongly convex, the upper margin nearly straight. Supra-ocular and hepatic spines are wanting, the gastro-hepatic groove slightly developed. The eyes are large, considerably depressed; seen from the side (fig. 4 *a*), they are somewhat longer than the whole stalk; seen from above, their basal margin is very oblique (fig. 4 *b*), so that the interior margin of the distal joint of the stalk is as long as the outer margin of the eyes. The antenn. ped. with the outer margin of the first joint is a little longer than that of the two other joints together, and only a little shorter than their inner margin; the second joint with the inner margin is three times longer than the breadth, and somewhat longer than the third joint, which is about two and a half times longer than broad. The antennal squama reaches nearly to the end of the antenn. ped., with its distal portion broad and the outer spine well developed. Mxp.^{3} is a little shorter than trl.^{2} The branchiæ present a transition-form between those of *S. arcticus* Kr. (Pl. XII. fig. 1 *c*) and *S. robustus* Smith; the pleurobranchial lamella above mxp.^{2} is very small. Of the branchiæ above trl.^{3}, *br.*^{1} is scarcely two-thirds as long as *br.*; of those belonging to trl.^{4}, *br.* is slightly longer than *br.*^{1}, and *br.*^{1} a little shorter than *br.*^{1} above trl.^{3} The ext. br. of urp. is almost five times longer than broad, and the hairy portion of its outer margin is a little more than one-fourth of the total length.—Length 36·5 mm.

This species occupies an intermediate position between *S. arcticus* Kr. and *S. robustus* Smith. Bate's fig. 4, showing an antennule and an eye, is misleading, the antennular peduncle being too slender, with the basal joint too short, the third joint too long.

Serg. japonicus Bate, p. 387, pl. lxx. figs. 1, 2.

Bate enumerates three specimens from two localities: Stat. 232, lat. 35° 11′ N., long. 139° 28′ E., 345 fathoms; and Stat. 207, lat. 12° 21′ N., long. 122° 15′ E., 700 fathoms. All have been preserved, and belong to one species. In 1896 I wrote that *S. japonicus* Bate must be identical with *S. mollis* Smith (taken in the Atlantic, off the United States), and gave reasons for my view. On comparing Bate's specimens with Smith's elaborate description (Rep. U.S. Comm. Fish & Fisher. for 1882, p. 419, 1884) and his figures (Rep. U.S. Comm. Fish &c. for 1885, pl. xx. figs. 3–5), I arrived at the same result. It should be especially mentioned that an examination of the branchiæ showed the most complete agreement with Smith's description and drawing. For full information on *S. japonicus* Bate, I refer, therefore, zoologists to the papers of Smith.

As already mentioned, I found in the bottle with *S. japonicus* from Stat. 232 a tube containing a smaller animal determined

to be *S. japonicus* and labelled Stat. 158. It is not mentioned in Bate's work. On a closer examination it turned out to be a specimen of *Petalidium*, and it has been described above.

Serg. kröyeri Bate, p. 388, pl. lxx. figs. 3, 4. (Plate XI. figs. 5 *a*, 5 *b*.)

Bate established this species on one large specimen, from Stat. 170, lat. 29° 55′ S., long. 178° 14′ W., 520 fathoms. The specimen is very mutilated; a new description with two figures (Pl. XI. figs. 5 *a*, 5 *b*) is here given.

The rostrum (fig. 5 *a*) is rather low, rounded above, with the upper front angle blunt and slightly projecting and the anterior margin concave; but it could not be settled whether the upper margin of the rostrum had been damaged or presented its natural shape. Supra-ocular and hepatic spines are wanting, the gastro-hepatic groove is strongly developed. The eyes (fig. 5 *b*) are large, somewhat depressed; seen from above nearly as long as broad, slightly longer than the outer, and decidedly, but not much, longer than the inner margin of the stalk. On the upper side of the stalk, close behind the eye and near the inner margin, is seen a rather small, subcylindrical, distally rounded process, directed obliquely forwards, inwards, and upwards; it seems to terminate in an organ. In the antenn. ped. the basal joint is broad, with the outer margin a little shorter than that of the two following joints together, but only two-thirds as long as the inner margin of the same joints; the second joint is stout, with the inner margin scarcely three times longer than the breadth; the third joint is stout, but yet considerably more slender than the second, scarcely three times longer than broad, somewhat longer than the outer and somewhat shorter than the inner margin of the second joint. The squama of the antennæ seems to be nearly as broad at the distal end as in *S. japonicus* Bate, but it could not be seen whether the outer spine is developed. Mxp.^{3} and all trunk-legs are wanting. The pleurobranchial lamella above mxp.^{2} is small. The branchiæ above trl.^{3} have been broken off on both sides; of the branchiæ above trl.^{4}, *br.* is nearly three-fourths as long as *br.* above trl.^{2}, while *br.*^{1} is slightly more than half as long as the same. The ext. br. of urp. with the apical part is wanting; the branch seems to have been at most four times longer than broad, perhaps without marginal spine, and with the haired part of the margin unusually short.—Length 60 mm.

The species is allied to *S. prehensilis* Bate and *S. robustus* Smith, but it is easily distinguished from all species hitherto discovered by the process on the eye-stalks.

Serg. atlanticus H. Milne-Edw., Bate, p. 389, pls. lxviii. & lxix.

In my earlier paper I wrote (p. 947) that "I am not convinced that all the specimens from the localities enumerated (p. 390) belong to *S. atlanticus*," and I produced some grounds for that

opinion. The investigation of the material preserved in the British Museum proved the correctness of my disbelief, but, it must be admitted, to a degree not supposed.

Of the specimens enumerated by Bate, the following have not been preserved in the British Museum: "Stat. 42, lat. 35° 58′ N., long. 70° 35′ W., 2425 fathoms," "length 25 mm."—and "On May 6–18th, 1876, in lat. 32° 41′ N., long. 36° 6′ W. . . one specimen . . . at the surface; and on the 7th of the same month, near the Azores . . . . two other specimens were taken at the surface." I can now state with certainty that if the specimen from Stat. 42 lived near the bottom in that enormous depth, it did not belong to *S. atlanticus*; perhaps it was captured near the surface, but at all events the locality must be omitted as uncertain. Most probably the specimens captured in May 1876 belonged to *S. atlanticus*. The specimens from the other stations enumerated by Bate belong to four species, and each station must be mentioned separately.

"North Atlantic . . . . Stations 62 and 63, on the passage from Bermuda to the Azores. Three specimens." In a bottle labelled "Between Bermudas and Azores" I found eight partly mutilated specimens of *S. atlanticus*.

"Between Teneriffe and St. Thomas." In a bottle with the same locality, three specimens of *S. atlanticus*.

"Station 320, ... lat. 37° 17′ S., long. 53° 52′ W., off Monte Video; depth 600 fathoms." Bate does not directly state the number of specimens, but he writes "Length 38 mm.," and the meaning is probably that he had one single specimen. In a bottle labelled "off Monte Video" I found six small and badly preserved specimens of *S. atlanticus* M.-Edw., and one large specimen of *S. arcticus* Kr., and it is decidedly the last-named specimen which was procured from 600 fathoms. As to *S. arcticus* Kr., the student is referred to Kröyer's work, to the description and drawings in various papers of S. Smith, to notes in my earlier paper, and to some remarks below, in the description of *S. similis*, n. sp., together with figs. 1 *a–c* on Pl. XII.

"Station 159, . . . south of Australia; depth 2150 fathoms. . . . Three specimens. . . Length 43 mm." In the collection three large specimens are present, but they belong to *S. arcticus* Kr., which thus has been proved to be distributed through the deeper Atlantic, from the southern part of Greenland to lat. 38° S., and to south of Australia.

Bate enumerates still two deep-water stations, viz. Stat. 232, off Japan, and Stat. 173, off Matuku, Fiji Islands; he examined one specimen from each of these localities, but the animals belong to two new species to be described below.

But before giving these descriptions I will sum up the results of the examination of the specimens referred by Bate to *S. atlanticus* H. Milne-Edw. (=*S. frisii* Kr.). The Copenhagen Museum possesses some hundreds of adult specimens of *S. atlanticus*, taken at a large number of places in the Atlantic, the Indian Ocean,

and the western part of the Pacific, and all these were taken near the surface; the 'Challenger' specimens taken near the surface and referred by Bate to *S. atlanticus* really belong to that species, but his specimens secured at the deep-sea stations 320, 159, 232, and 173 belong to three other species.—I have found it unnecessary to attempt to point out what parts of Bate's long description (and which of his drawings) can be applied to *S. atlanticus*; the zoologist is referred to the good description of Kröyer together with the additional notes in my earlier paper.

Serg. similis, n. sp. (Plate XI. figs. 6 *a*–6 *d*.)

The type of this species is the above-mentioned specimen on which Bate writes (p. 320): "Stat. 232, . . . lat. 35° 11′ N., long. 139° 28′ E., off Japan; depth 345 fathoms. . . . Length 50 mm." The species is closely related to *S. arcticus* Kr. The rostrum (fig. 6 *b*) is nearly oblong-triangular, a good deal longer than in *S. arcticus* (Pl. XII. fig. 1 *b*) and directed more upwards; the anterior margin of the scutum below the rostrum is strongly convex (fig. 6*a*) and protruding, while it is nearly vertical in *S. arcticus* (Pl. XII. fig. 1 *a*). The supra-ocular and hepatic spines are well developed; the gastro-hepatic groove distinct. The eyes are nearly as in *S. arcticus*, large, broader than deep, scarcely as long as broad (fig. 6 *c*), decidedly shorter than the outer margin of the distal joint of the stalk, and one-half shorter than its inner margin. The antenn. ped. (fig. 6 *c*) is about as in *S. arcticus*; the outer margin of the basal joint is as long as the same margin of the two distal joints together; the second joint is rather slender, its inner margin almost four times longer than its breadth and scarcely longer than the third joint, which is slender, about six times longer than broad. The squama of the antenna is moderately broad at the end, with the outer spine projecting beyond the terminal margin. Of the long appendages, mxp.^{3}, trl.^{3}, and trl.^{5} are wanting, and the remaining thoracic legs are about as in *S. arcticus*. The branchiæ above trl.^{3} and trl.^{4} (fig. 6 *d*) present excellent differences from those in *S. arcticus* (Pl. XII. fig. 1 *c*); *br.*^{1} above trl.^{3} is not quite half as long as *br.* above trl.^{4}, and in spite of this not inconsiderable length it is semi-rudimentary, having only some posterior branches, nearly all short, and no anterior branches. Of the branchiæ above trl.^{4}, *br.* is long, four-fifths as long as *br.* above trl.^{3}; *br.*^{1} is more than half as long as *br.*, very well developed, at least as long and more than twice as broad as *br.*^{1} above trl.^{3} [In *S. arcticus* (Pl. XII. fig. 1 *c*)—from a specimen obtained in the most northern part of the Atlantic—*br.*^{1} above trl.^{3} is about three-fourths as long as *br.* above trl.^{4}, with well-developed branches on both sides; of the branchiæ above trl.^{4}, *br.* is only a little more than half as long as *br.* above trl.^{3}, while *br.*^{1} is small, considerably narrower and shorter than *br.*^{1} above trl.^{3}] The ext. br. of urp. has the apical portion broken off, but it is narrow, and seems to have been a little more than five times longer than broad, thus slightly narrower than in *S. arcticus*, but otherwise of the same

shape and with the marginal spine well developed.—Length 54 mm.

The species is easily distinguished from *S. arcticus* Kr. by the shape of the rostrum, together with the anterior margin of the scutum, and especially by the branchiæ above trl.^{3} and trl.^{4}; in all other features these two species are closely allied.

Serg. challengeri, n. sp. (Plate XII. figs. 2 *a*–2 *n*.)

The type of this species is the specimen on which Bate writes (p. 390): "Station 173, July 24th, 1874; lat. 19° 9′ 35″ S., long. 179° 41′ 50″ E.; off Matuku, Fiji Islands; depth 315 fathoms; bottom, coral mud. One specimen, male. Dredged. Length 24 mm." He referred it to *S. atlanticus*. I have the pleasure of appending the name of the renowned ship to this *Sergestes*, which is one of the most interesting species of Crustacea secured by the expedition. Unfortunately the single specimen is very mutilated.

The rostrum (fig. 2 *b*) is rather low, short, obliquely triangular, turning somewhat upwards; its apex is acute and very slightly produced. The supra-ocular spine is wanting; the hepatic spine is rudimentary; the gastro-hepatic groove (fig. 2 *a*) is deep, and the cervical groove very distinct. The eyes have been broken off, only the basal part of the stalks being left. In the antenn. ped. (fig. 2 *c*) the outer margin of the basal joint is a little longer than that of the two other joints together; the second joint is moderately robust, its inner margin a little more than three times longer than the breadth; the third is slightly more than two and a half times longer than broad, a little shorter than the outer margin of the second joint, and only three-fifths as long as the inner margin of the last-named joint. The squama of the antenna is distally very broad (fig. 2 *c*), with the outer spine scarcely projecting beyond the terminal margin. Mxp.^{3} and trl.^{3}–trl.^{5} are wanting; of trl.^{1} the apical part has been lost, but these legs seem to have been a little longer than mxp.^{2}, and to be more slender than in *S. arcticus*, but otherwise not showing any difference of importance. Of the branchiæ (fig. 2 *d*), *br.* above trl.^{2} and trl.^{3} are long and narrow; *br.*^{1} above trl.^{2} is as usual a lamella; *br.*^{1} above trl.^{3} is slightly more than one-third as long as *br.*, especially with its anterior branches well developed; of the branchiæ above trl.^{4}, *br.* is about three-fourths as long as *br.* above trl.^{3}, while *br.*^{1} is proportionately large, much longer and broader than *br.*^{1} above trl.^{3}, and even more than half as long as *br.* above trl.^{3} The ext. br. of urp. (fig. 2 *l*) has the apical portion wanting, but the branch seems to have been nearly five times longer than broad, with the marginal spine well developed and situated as in *S. arcticus*.—Length 23 mm.

By the shape of the joints of the antenn. ped., the development of the branchiæ above trl.^{3} and trl.^{4}, and the shape of the ext. br. of urp., this species is related to *S. robustus* Smith, *S. prehensilis* Bate, and *S. kröyeri* Bate. *But it is sharply distinguished from*

all other species hitherto known by possessing an enormous multitude of luminous organs arranged regularly on the lower surface and near the lower lateral margins of the cephalothorax, on the six abdominal segments (figs. 2 *d*, *i*, *k*), on the sides of the shield (fig. 2 *a*), and on all the appendages preserved (figs. 2 *c*, *d*, *e*, *f*, *g*, *h*) with exception of the maxillulæ and maxillæ. The organs are easily seen; they look almost similar to the eyes in Araneæ, and they differ much in size and direction. I have deemed it advisable to deal with the special arrangement and the structure of these organs in a separate section of this paper.

Serg. dorsispinalis Bate, p. 394, pl. lxxii. fig. 1.

Bate does not state directly the number of specimens, but he had probably only one. The length is "9 mm." and the locality "south of Australia, March 1874." An animal with a label of exactly the same contents was preserved in a microscopical preparation. It is a *Mastigopus* related to *S. arcticus* Kr., *S. similis*, n. sp., &c., but it could not be referred to any adult form. In the preparation the abdomen is seen from the side, and the cephalothorax essentially from below; the spine on the scutum on which Bate writes "just anterior to the [cervical] suture, in the median dorsal line, is a small, anteriorly directed tooth," is in reality the gastro-hepatic spine, which besides has been drawn in a position too remote from the front. Bate's figure is not correct in some other respects: in the antenn. ped. the second joint is about as long as the third, and both together somewhat shorter than the first; the eyes reach to the end of the first joint; the squama is longer than in the figure, reaching almost beyond the second joint of the antenn. ped. and distally narrow; the ext. br. of urp. is a little longer and conspicuously more narrow than in the figure, while its marginal tooth is indicated correctly.

Serg. laterodentatus Bate, p. 395 (no figure).

Bate has examined one specimen, measuring 8 mm. in length, and captured "south of Australia, March 1874." The type could not be found in the Museum. According to the description it is a *Mastigopus* belonging to the *arcticus*-group, probably a younger stage of the same species as that to which the preceding larva, *S. dorsispinalis* Bate, belongs.

Serg. nasidentatus Bate, p. 398, pl. lxxii. fig. 2.

Bate does not state directly the number of specimens, and presumably he had only one; the length was 10 mm. and the locality the Pacific Ocean, between Valparaiso and Juan Fernandez. The type does not exist in the Museum. The species is a *Mastigopus*; in my earlier paper I had already referred it to the same group as *S. arcticus*, and nothing further can now be added.

Serg. diapontius Bate, p. 399, pl. lxxii. fig. 3.

Bate does not state the number of specimens, but presumably

he had only one. The length is 18 mm. and the locality the Atlantic Ocean, April 7, 1876. In a preparation bearing the name of the species, and besides "Surface, 7 April, 1876, Atlantic," one specimen is preserved: it must be Bate's type, but it measures only 16·5 mm. in length. In Bate's figure the armature on the dorsal line of the abdomen is not correct; on the third segment a spine has either been broken off or is rudimentary, the base being distinct; the spine on the fourth segment is only half as long as that on the fifth, shorter than in the figure, and directed obliquely backwards; on the sixth segment a very short spine is visible. The basal part of the rostrum is somewhat ascending, the distal spiniform and horizontally porrected. The ext. br. of urp. has the outer margin hairy in about $\frac{8}{9}$ of its length, and the marginal tooth is very small. The distal part of mxp.^{3} is very incorrectly drawn by Bate in his fig. 3 *i*; it is four-jointed; the third joint is short, much shorter than the fourth, and both together about as long as the second; the first of these joints terminates below in two strong setiform spines, both somewhat longer than the second joint, which terminates in two spines of the same length as the preceding pair; the fourth joint terminates also in two spines, somewhat, but not much, shorter than the four just mentioned. (I cannot understand how Bate drew his misleading figure; it must prevent every student of his Report from arriving at a correct judgment.) In the British Museum I have drawn tolerably accurate sketches of the rostrum, the ext. br. of urp. and the distal part of mxp.^{3}, and I have compared them with a few specimens in the Copenhagen Museum, previously determined and shortly described by me as the *Mastigopus* of *S. penerinkii* Bate, H. J. H.: I found the agreement to be so close, that I must consider *S. diapontius* Bate and *S. penerinkii* Bate (the type of the latter form unfortunately is not present in the Museum) as two *Mastigopus*-stages of the same species; the type of *S. penerinkii* Bate measured only 8 mm. in length and is a young *Mastigopus*, while *S. diapontius* Bate is the large larva.

Bate describes *S. diapontius* on p. 399, *S. penerinkii* on p. 418; and the name *S. diapontius* must therefore be accepted for the species. In my earlier paper I described the black-eyed adult form as *S. penerinkii* Bate, H. J. H., but I think that it must now be necessary to adopt the name *S. diapontius*, not only for the *Mastigopus*, but also for the mature form, which therefore in the future must be named *S. diapontius* Bate, H. J. H.

Serg. armatus Kröyer, Bate, p. 401, pl. lxxiii. fig. 1.

Bate enumerates three localities: one of them is "September 12, 1875, between Japan and Honolulu, South Pacific Ocean"; the second is "Station 256, July 21, 1875; . . . . north of the Sandwich Islands; depth 2950 fathoms." But in the collection I found a statement aberrant from both, viz.: "Surface. Japan to Honolulu, July 1875. Type." This bottle contained two

small specimens, but neither of them can be the type for Bate's figure. Both specimens belong to Group II. in my earlier paper, but neither of them belongs to *S. armatus*, both having on the rostrum a well-developed sub-basal dorsal spine, which is absent in *S. armatus* Kr. and in Bate's figure. I have been unable to refer the specimens, which measure about 8·5 and 11 mm., to any species known to me, and I thought it useless to describe and figure them.—One specimen from Port Jackson, Australia, the third locality in Bate's report, measures at most 5·2 mm. without the rostrum, which has been broken at the middle, but possesses a very fine sub-basal spine. It is so small and so badly preserved that a reference to any species has been impossible.

Finally I found a specimen from "Sidney," determined by Bate as *S. armatus*, but not mentioned in his work. It is only as long as the preceding specimen and impossible to determine.

The result is that I have perhaps not seen the specimen figured by Bate, which may belong to *S. armatus* Kr., and, according to the explanation of the plate, measured about 10 mm. in length, while his specimens of this length examined by me disagree with his figure by possessing a sub-basal upper spine on the rostrum.

Serg. edwardsii Kröyer, Bate, p. 403, pl. lxxiii. fig. 2.

Bate enumerates three localities. The first is "North Atlantic, April 1873": in the Museum I found a specimen labelled "14 April, 73, off Africa, surface," which most probably is that indicated in the text, and it belongs to *S. edwardsii* Kr. The second locality is "Pacific Ocean, surface, September 1875": in the collection a specimen bearing the same inscription is *S. edwardsii* Kr. From the third of Bate's localities, Cape Verde Islands, I found no specimen, but a specimen without locality and signed "type" is an adult specimen of *S. edwardsii* Kr. (That Bate's statement "Greenland (*Kröyer*)" is wrong here, and in almost all other places, has already been pointed out both by Ortmann and myself.)—Furthermore, I found two small specimens of *S. oculatus* Kr., the *Mastigopus* of *S. edwardsii* Kr., which had been determined by Bate as *S. edwardsii* and labelled "Aug. 23, 1873, lat. 2° 25′ N., long. 20° 1′ W., 100 fathoms," but these specimens are not mentioned in Bate's Report.

Bate's description of the characters of *S. edwardsii* Kr. is incomplete; the reader is referred to my earlier paper.

Serg. rinkii Kröyer, Bate, p. 404, pl. lxxiii. fig. 3.

Bate mentions two localities: "New Hebrides, August 23, 1874," and "South Pacific, 1875." From the first of these localities the anterior half of a specimen was present. Furthermore, I found two specimens labelled "Oct. 19, 1875, S. Pacific, drawn," and one and a half specimen labelled "Oct. 18, 1875, surface": both these localities are in all probability identical with the second one in Bate's Report. It may be very possible that all these specimens belong to *S. rinkii* Kr., which is the *Mastigopus*

of *S. arcticus* Kr., but having in London no material from the North Atlantic of *S. rinkii* Kr., for direct comparison of minute details, and some other species allied to *S. arcticus* being known from the Indian Ocean and the Pacific, I could not determine the larvæ enumerated with absolute certainty.

One specimen from Cape York, determined as *S. rinkii*, but not mentioned in the Report, is *S. corniculum* Kr., in a stage a little younger than that figured by Bate as the last-named species.

One specimen, labelled "25. 8. 73," determined as *S. rinkii*, but not mentioned in the Report, measures nearly 7 mm.; it belongs to *S. penerinkii* Bate, the young larva of *S. diapontius* Bate, H. J. H.

Serg. oculatus Kröyer, Bate, p. 406, pl. lxxiv. fig. 1.

Bate enumerates six localities. From Stat. 106 three specimens were obtained, from Stat. 257 one specimen, from Stat. 103 one specimen, finally from "September 12, 1875, South Pacific," one specimen: all six specimens correctly referred to the Kröyerian species, which is the *Mastigopus* of *S. edwardsii* Kr. (compare my earlier paper). From the two remaining localities, viz. "North Pacific, near the Sandwich Islands, August 21, 1875," and "August 27, 1873 . . . off St. Paul's Rock," no specimens could be discovered.

Serg. ovatoculus Bate, p. 408, pl. lxxiv. fig. 2.

Bate gives the locality "The North Atlantic Ocean." In the collection I found three specimens with the label "14 June, 1873," which agrees with my quotation from the text. These three specimens are identical with *S. ancylops* Kr., which is the *Mastigopus* of *S. atlanticus* H. Milne-Edw.

Serg. parvidens Bate, p. 409, pl. lxxiv. fig. 3.

Bate has the following localities: "The tropical part of the Atlantic; Pacific Ocean, north of the Sandwich Islands; off Sydney and Wellington, Australia." Just below he writes: "Specimens of this species or variety were taken during the passage from Teneriffe to St. Thomas"; and in the collection one specimen from the last-named locality is present: it belongs to *S. vigilax* Stimpson, the *Mastigopus* of *S. vigilax* Stimps., H. J. H.; it agrees with Bate's description and figure, and it had already been pointed out by Ortmann and myself that *S. parvidens* Bate belonged to *S. vigilax* Stimps. Examples from the other localities mentioned by Bate could not be found.—From "Cape York" two specimens determined as *S. parvidens* were present: one of them is a young *S. oculatus* Kr. (the *Mastigopus* of *S. edwardsii* Kr.); the other is allied to *S. incertus* H. J. H., but is so badly preserved that a determination was impossible. In a preparation a small specimen from the "China Sea," determined as *S. parvidens*, was preserved; it seems to be *S. oculatus* Kr., but it is in a very bad condition.

Serg. corniculum Kröyer, Bate, p. 410, pl. lxxv. fig. 1.

Bate writes: "Cape York; north of New Guinea; North-west Pacific." In the collection I found one specimen from Cape York labelled "type," furthermore, one and a half specimen from the same locality, all correctly referred to the Kröyerian species. In a preparation I found a specimen determined as *S. corniculum* from "N.W. Pacific"; it measures 10·4 mm. in length, but according to the shape of the ext. br. of urp., the eyes, &c., it is not that species but *S. ancylops* Kr., the *Mastigopus* of *S. atlanticus*. From the third locality, "north of New Guinea," no specimen could be found.

Serg. ancylops Kröyer, Bate, p. 413, pl. lxxv. fig. 2.

Bate has two localities: "New Hebrides; Pacific, July 20, 1875." I found one specimen from "New Hebrides" correctly referred to the Kröyerian form.—In three other tubes, specimens not mentioned in Bate's text were present; they belonged to three other species, but are mutilated and could not be determined.

Serg. longirostris Bate, p. 415, pl. lxxv. fig. 3.

Bate writes: "Mid Atlantic, April 1876," and according to the following line he had one specimen. But in the collection I found three tubes, each containing one specimen, all determined as *S. longirostris*, and two of them from "N. Atlantic," while the third had no locality; all three specimens are the young *Mastigopus* of *S. corniculum* Kr., H. J. H. The specimen without locality seems to be the type for Bate's figure of *S. longirostris*, but it measures scarcely 3 mm. in length, the rostrum not included, and in Bate's figure the eye-stalks are too long, the eyes too small, and the third joint of the antenn. ped. too short (it is in reality as long as the second).

Serg. junceus Bate, p. 416, pl. lxxvi. fig. 1.

According to the text Bate has seen one small specimen from the "South Pacific Ocean." It could not be detected in the collection. But in my earlier paper I pointed out that it must be the young *Mastigopus* of *S. tenuiremis* Kr., H. J. H.

Serg. longispinus Bate, p. 417, pl. lxxvi. fig. 2.

Bate has two localities: "Station 106 . . . Mid Atlantic" . . . and "Station 354 . . . . North Atlantic Ocean." The collection contained two specimens referred to this species and labelled "23 Aug. 1873, 70 meters"; in the text we find "Station 106, August 25, 1873; lat. 1° 47′ N., long. 24° 26′ W.; Mid Atlantic Ocean"; but in spite of the small difference as to the date (probably originating from a misscript) I am sure that one of the two specimens was captured at Stat. 106. The other specimen is probably from Stat. 354. Bate writes: "the specimen from the tropical part of the Atlantic" and "that from the North Atlantic," which indicates that he had only one specimen from

each of the two stations mentioned; and I suppose, therefore, that both specimens have later on been put together in the same tube. Both specimens, which are in a very bad condition, belong correctly to *S. longispinus* Bate (the direction of some of the dorsal spines on the abdomen is very characteristic), and this form is in reality the *Mastigopus* of *S. cornutus* Kr. (compare my earlier paper, p. 953).

SERG. PENERINKII Bate, p. 418, pl. lxxvi. fig. 3.

Bate records the length to be 8 mm. and the locality "North Atlantic Ocean." No specimen referred to this species could be found in the collection. But above I have mentioned a specimen of this species referred by Bate to *S. rinkii*, and it may perhaps be that described by him as *S. penerinkii*. He writes (p. 419) that the last-named "species bears a strong resemblance to *Sergestes rinkii* Kröyer, but differs . . .". The specimen in question, referred by him to *S. rinkii*, measures nearly 7 mm. in length and was captured "25. 8. 73," that is to say, Mid Atlantic.—In my earlier paper I have described the *Mastigopus*, and besides the mature form as *S. penerinkii* Bate, H. J. H.; but above it is pointed out that this name must be cancelled as a synonym, and the species be named *S. diapontius* Bate, H. J. H.

SERG. FERMERINKII Bate, p. 419, pl. lxxvi. fig. 4.

Bate has examined one specimen, captured in the "Pacific Ocean, lat. 24° S., long. 148° W.," and measuring 5 mm. The specimen is not to be found in the Museum collection. According to the figure it is a very young *Mastigopus* belonging either to *S. diapontius* Bate, H. J. H., or to a closely-allied species of the same group.

SERG. LONGICOLLUS Bate, p. 421, pl. lxxvii. fig. 1.

Bate enumerates two localities. The first of them is "South Atlantic Ocean, October 5, 1873; near Station 131; lat. 29° 35′ S., long. 28° 9′ W." In a preparation labelled "5. 10. 73" I found the large specimen drawn by Bate; in a tube labelled "surface, at night, 5 Oct. 1873, South Atlantic," a small specimen was preserved. Thus both specimens are from the first locality in the text, and both belong to *S. longicollus* Bate, which is the *Mastigopus* of *S. tenuiremis* Kröyer, H. J. H. In the large specimen drawn by Bate the eyes present a thick yellowish layer around the black central part; the dorsal spine on the sixth abdominal segment is exceedingly small.

The second locality in Bate's text is "Station 295, November 5, 1875; lat. 38° 7′ S., long. 94° 4′ W.; South Pacific Ocean; depth 1500 fathoms; . . . Taken at night." In the collection a specimen is preserved labelled "5. Nov. 75, night, S. Pacific, surface." The determination is correct; and the specimen, which measures 9·2 mm. in length, is evidently that mentioned by Bate; but the label proves that it was taken at the surface, wherefore

the depth recorded in the text is most misleading.—In a third tube two specimens labelled 18/10 75 were preserved; they had been correctly referred by Bate to his *S. longicollus*, but are not mentioned in his text.

A preparation contained a specimen of the same species, labelled "*Sergestes tenuiremis*, South Atlantic, 6. 10. 73." It is not mentioned by Bate, who even writes (p. 421) that "No specimen in the 'Challenger' collection corresponds precisely with the description and figure given by Kröyer" of *S. tenuiremis*. On the other hand, *S. tenuiremis* Kr. and *S. longicollus* Bate are, as already stated, the same species.

Serg. præcollus Bate, p. 423, pl. lxxvii. fig. 2.

Bate has examined one specimen, measuring 25 mm., from the "North Pacific Ocean." The specimen could not be found. The shape of the eyes in Bate's figure shows that it has been a large *Mastigopus*. In my earlier paper I write (p. 958): "is at least rather nearly related to *S. corniculum* Kr., from which it seems to differ by a somewhat different shape of the ext. br. of urp., and by having the fifth abdominal segment 'dorsally produced to a point.'"

Serg. semiarmis Bate, p. 423, pl. lxvii. fig. 1.

Bate has two localities: "West Pacific Ocean" and "Station 354, May 6, 1876; .... Mid North Atlantic." After the description he writes: "*Observations*.—A specimen (pl. lxvii. fig. 2) very similar to the type was taken in the Atlantic . . ."; and then he describes the specimen. I must suppose that he considered the specimen from the "West Pacific Ocean" to be the type of his *S. semiarmis*, and that the specimen described separately (p. 425) is that from ". . . May 6, 1876. . . ." Neither of the specimens could be detected in the Museum; both are larvæ, but a reference is impossible. In the collection I found one specimen determined as *S. semiarmis* and labelled "13 April 1876, Atlantic, off coast of Africa, surface"; it is a *Mastigopus* of *S. diapontius* Bate, H. J. H.

Serg. læviventralis Bate, p. 425, pl. lxvii. fig. 3.

Bate had probably only one specimen, 7 mm. in length, from "North of New Guinea"; it could not be found in the Museum. It is a young *Mastigopus* belonging to a species closely related to *S. arcticus* Kr.

Serg. spiniventralis Bate, p. 426, pl. lxvii. figs. 5 & 6.

Bate has only one locality: "North Pacific Ocean"; the animal described measured only 3·5 mm. in length, and some of its parts are shown in figs. 5 *a*, 5 *l*, and 5 *v*, but fig. 5 *v*, representing the ext. br. of urp., does not correspond at all with the description in the text (p. 427). The animal is not to be found in the collection; it is a small *Mastigopus* related to *S. vigilax* Stimps. and allied species. Bate's fig. 6 *a* represents the head

of "*Sergestes spiniventralis* var." from the "West Pacific"; it has been suggested that the animal is allied to—or identical with—the *Mastigopus* of *S. vigilax* Stimps., H. J. H., but the specimen could not be found. The collection contained one specimen determined as *S. spiniventralis* and labelled "Sidney to Wellington, 17. 6. 74"; it measures about 7·5 mm. in length, and the naked part of the outer margin of the ext. br. of urp. is slightly more than one-fourth of its length. The specimen is in all probability a young *Mastigopus* of *S. vigilax* Stimps., H. J. H.

Serg. profundus Bate, p. 428 (no figure). (Plate XI. figs. 3*a*, 3*b*.)

Bate has referred two specimens to this species. He describes each specimen separately: the first of them, from Stat. 137, belongs to *Petalidium*, perhaps to *P. foliaceum*, and has been dealt with above. The other specimen, from "Stat. 300, December 17, 1875; lat. 33° 42′ S., long. 78° 18′ W.; west of Valparaiso; depth 1375 fathoms; .... Trawled," is a real *Sergestes*, related to *S. inous* Faxon, but differing in the shape of the rostrum. Having removed the first-mentioned specimen from the genus *Sergestes*, I should think it justifiable to apply the name *S. profundus* Bate to the last-named specimen, instead of proposing a new name. The animal is quite membranous, and is crimson everywhere—a fact proving that it lives in the depth of the sea, and that its colour has been durable to the highest and most unusual degree. The posterior part of the abdomen is wanting, and the animal is on the whole so mutilated and flabby, that I would have omitted it if it had not been described by Bate; but for that reason I have thought it necessary to add some notes with two figures (Pl. XI. figs. 3*a*, 3*b*). It agrees with *S. inous* Fax. as to the membranous quality of the skin and the posterior branchiæ, but differs from it in the shape of the rostrum, which is of moderate length, with the upper margin somewhat, and the lower margin partly, strongly convex, and distally it is produced in a moderately short spine (Pl. XI. fig. 3*b*). (Unfortunately I have not seen any specimen of the gigantic species *S. inous* Fax., and can therefore not decide whether the specimen described by Faxon had the rostrum uninjured.) Supra-ocular and hepatic spines are wanting. The eyes (Pl. XI. fig. 3*a*) are black, comparatively small, somewhat shorter than broad, not half as long as the eye-stalks, and not broader than the distal end of the stalks. In the antenn. ped. the outer margin of the first joint is almost as long as that of the two distal joints together, therefore somewhat shorter than their inner margin; the third joint is a little shorter than the inner margin of the second, and seems to be about three and a half times longer than deep. The squama does not reach the end of the antenn. ped., and the outer distal spine is well developed. According to Bate the part preserved measures 18 mm., and the probable length of the entire animal is 24 mm.

Serg. ventridentatus Bate, p. 431 (no figure).

Bate gives the locality "north of the Sandwich Islands" and the length "7 mm." A specimen labelled in accordance with the text is preserved in balsam; it is a young *S. oculatus* Kr., the *Mastigopus* of *S. edwardsii* Kr.

Serg. utrinquedens Bate, p. 433 (no figure).

Bate gives the locality "North Pacific Ocean," and the length "3·5 mm." No specimen could be found in the collection. Bate's specimen is a very young *Mastigopus*; in my earlier paper I have placed it near *S. corniculum* Kr., but a final interpretation is impossible to me.

Serg. dissimilis Bate, p. 437 (no figure).

In the collection one specimen, from Cape Verde Islands, is preserved; it is certainly the type described by Bate. In my earlier paper I had determined it as one of the larval stages of *S. arcticus* Kr., but this is not correct. The rostrum is slightly more than one-third the length of the eye-stalks, its basal part somewhat ascending, with a very small spine on the upper angle, its distal part is a slender horizontal spine. The hepatic spine is short. The eyes are only a little higher than the distal end of the eye-stalks, and these increase gradually in thickness from the base outwards. In the antenn. ped. the distal half of the first joint has the margins nearly parallel, and the two other joints are a little thicker than in the corresponding *Mastigopus* of *S. arcticus*. Fourth to sixth abdominal segments each with a very small dorsal spine directed backwards; the spine on the sixth segment is the longest. The ext. br. of urp. is almost, but not quite, five times longer than broad. All these characters agree with those found in a *Mastigopus* of *S. mediterraneus* H. J. H. preserved in the Copenhagen Museum; and sketches drawn in London of the shape of the distal part of the squama and the telson agree also with the last-named form. I must therefore consider *S. dissimilis* Bate as identical with *S. mediterraneus* H. J. H. The result is that the last name must be withdrawn as a synonym, and the species, of which the sub-adult stage has been described in my earlier paper, must be called *S. dissimilis* Bate, H. J. H.

II. *Some Results of the Investigation.*

In my earlier paper on *Sergestes* I have paid as much attention as possible to the animals described by Bate; in nearly all cases I was able to state whether the specimen was an adult form or a *Mastigopus*, and several of the species were interpreted. After the study of the material preserved in the British Museum, I have now been able to confirm most of my earlier statements, to interpret an additional number of the specimens mentioned by Bate, and to correct two faults committed by myself. I had erroneously referred *S. dissimilis* Bate to *S. arcticus* Kr., instead of identifying it with *S. mediterraneus* H. J. H. (see above).

Furthermore, I had divided a number of species, enumerated on p. 949 as Group I. A. *b.* β, into two sections, according to difference in the thickness of the distal joints of the antenn. ped.; but a study of the types of *S. prehensilis* Bate and *S. kröyeri* Bate showed that Bate's drawings of the antennulæ of these species are incorrect and misleading, wherefore my arrangement of them was wrong.

It may be useful to put together the alterations and additions which may now be accepted in the Conspectus on pp. 949–51 in my earlier paper. In Group I. the following particulars must be added or altered:—To *S. atlanticus* H. M.-Edw. belongs only a part of *S. atlanticus* sens. Bate, besides the form referred by Bate to *S. ancylops* Kr. From *S. arcticus* Kr., *S. dissimilis* Bate must be removed, and the latter species is to be established separately with *S. mediterraneus* H. J. H. as a synonym; furthermore, some of the specimens referred by Bate to *S. atlanticus* belong to *S. arcticus*. Near *S. arcticus* Kr., must be inserted *S. similis* H. J. H., established on one of Bate's specimens of *S. atlanticus*. *S. prehensilis* Bate and *S. kröyeri* Bate must be removed from their place and inserted above near *S. japonicus* Bate, together with *S. profundus* Bate, in its new restriction, and *S. challengeri* H. J. H., established on one of the specimens referred by Bate to *S. atlanticus*. *S. longirostris* Bate must be withdrawn as being a *Mastigopus* to *S. corniculum* Kr., H. J. H., and *S. corniculum* sens. Bate is the same species. As uncertain remain: *S. dorsispinalis* Bate, *S. laterodentatus* Bate, *S. nasidentatus* Bate, *S. læviventralis* Bate, *S. rinkii* Bate, ? Kr., all larval forms belonging to species related to *S. arcticus* Kr., or perhaps partly belonging to *S. arcticus* itself; furthermore, the larvæ *S. præcollus* Bate, *S. utrinquedens* Bate—both at least rather closely related to *S. corniculum* Kr., H. J. H.,—and *S. semiarmis* Bate.

In Group II. there is hardly anything to alter, but some additions to make. To *S. edwardsii* Kr. belongs *S. edwardsii* Kr., Bate, *S. oculatus* Kr., Bate, *S. intermedius* Bate, and *S. ventridentatus* Bate. *S. penerinkii* Bate must be cancelled as synonymous with *S. diapontius* Bate; and the adult form described as *S. penerinkii* in my earlier paper must be named *S. diapontius* Bate, H. J. H. The rest of Group II. remains unaltered. *S. fermerinkii* Bate, *S. spiniventralis* Bate, and the species referred by Bate to *S. armatus* Kr. could not be interpreted.

Besides, the investigation has yielded some results on the bathymetrical and geographical distribution of some of the species. It has been proved that the large specimens (exceeding 30 mm. in length) referred by Bate to *S. atlanticus* Kr. are deep-sea forms belonging to other species: *S. atlanticus* is common near the surface; according to Ortmann it has been taken in the intermediate net from 700–500 m., but it does not live in the greater depths of the sea. *S. arcticus* Kr. has a very wide geographical range, through the deeper to very deep tracts of the Ocean (see above); *S. japonicus* Bate has been captured in the northern part of the Atlantic and the northern part of the

Pacific. *S. atlanticus* H. Milne-Edw., *S. edwardsii* Kr., *S. vigilax* Stimps., H. J. H., *S. tenuiremis* Kr., H. J. H., and *S. corniculum* Kr., H. J. H., have been proved to be distributed through the tropical and subtropical parts of the Oceans almost around the globe, viz., from lat. 23° N., lat. 32° N., or even lat. 42° N. in the Atlantic, throughout the Indian Ocean to Australia, New Hebrides, and "South Pacific."

III. *Luminous Organs in* Sergestes challengeri, n. sp. (Plate XII.)

The luminous organs briefly mentioned above are generally easy to discover; each resembles a very convex, vitreous, faintly yellowish lens, which is circular and sharply defined. They differ much in size, some of them being very small and many proportionately large. It may be advisable, first, to give a conspectus of the organs observed on the single and unfortunately very mutilated specimen, next to add some remarks on their distribution, then to describe their structure, finally to compare them with luminous organs in other Crustacea.

Conspectus of the Organs observed.

	Organs.
On each side of the scutum a row with four organs.	8
On the clypeus one organ	1
On the lower side of the head one unpaired organ and one near the lateral margin	3
On the lower surface of the thorax and on its infero-lateral margins	26
On the lower side of the third joint of the antenn. ped. one organ	2
On the lower side of each squama four organs	8
On the mandible and its palpus two organs	4
On the first maxilliped two organs	4
On the second maxilliped five organs	10
On the first trunk-leg three organs	6
On the lower surface and on the lateral wall of the first abdominal segment	6
Do., do. of the second abdominal segment	6
Do., do. of the third abdominal segment	4
Do., do. of the fourth abdominal segment	3
On the lateral wall of the fifth abdominal segment.	2
Along the median line of the sixth abdominal segment.	6
On the outer side of the basal joint of each of the pleopods one organ	10
On the peduncle and on the inner branch of each uropod two organs	4
On the lower side of the outer branch of each uropod two organs	4
Total number of organs ...	117

The eye-stalks, the maxillipeds, and the four posterior pairs of the trunk-legs have been broken off. I am convinced that at least most, and perhaps all, these appendages possess some organs, and the lowest number the species possesses must therefore be about 150!

On the distribution and direction of these organs the following remarks may be offered. The four organs on each side of the scutum are arranged rather close in a longitudinal row situated on the ridge bordering the branchial cavity above (fig. 2 *a*). The organ on the clypeus is large: one organ is situated on the segment bearing the antennulæ, and one on the lower surface of the head near the lateral margin a little in front of the mandible; these four organs look essentially downwards. The arrangement of the organs on the three posterior thoracic segments can be seen in figs. 2 *i* and 2 *d*. It is observed that two large organs are placed at the lower margin of *br.* above trl.^{3} and of *br.*^{1} above trl.^{4} These organs look outwards and downwards, and the part containing the glandular mass &c. behind the lens is somewhat protruding, which produces an aspect as if these organs had been inserted on the end of a kind of rather thick, short stalk. The remaining organs on the segments mentioned are found on the lower surface (fig. 2 *i*); those placed at the inner angle of the legs are small or very small, while some in the median line are large. In fig. 2 *i* fifteen thoracic organs have been drawn; the remaining eleven thoracic organs are situated on the anterior segments and arranged in a rather similar way. The four organs on the lower surface of each squama of the antenna are arranged for some distance in a row; two of them are seen through the squama in fig. 2 *c*. The mandible (fig. 2 *e*) has one organ below at the antero-inferior margin near the insertion of the palp; another organ is seen on the lower surface of the first joint of the palp near its distal end. The first maxilliped (fig. 2 *f*) has on the upper side one organ just at the origin of the exopod, and one on the lower side of the following joint of the endopod; the first-named organ looks forwards and a little inwards (fig. 2 *g*), and the upper margin above it is produced nearly as a lamella, overlapping the major part of the lens when seen from above (figs. 2 *g* & 2 *n*). Of the organs on the outer—in the natural position of the appendage in reality the lower—surface of mxp.^{2} (fig. 2 *h*), that at the base of the third joint is very small and the others large; the organ on the first joint looks essentially downwards, and is "stalked," as the above-described organs near the lower margin of the posterior branchiæ. Of the three organs on trl.^{1}, two are placed on the inner side of the long fourth joint, one near the base and the other near the distal end; the third organ is situated on the anterior side near its end. Each of the five anterior abdominal segments has a large organ on the lower part of the anterior margin of the lateral plate (figs. 2 *d* & 2 *i*); it looks forwards and somewhat downwards, besides sometimes a little outwards. Each of the two anterior segments has besides

on the lower surface (fig. 2 *i*) four organs, one of which is large and two of the others very small; on the third and fourth segments these organs are gradually reduced in number, and none of them are found on the fifth. The sixth abdominal segment has a median row of six organs, which are seen in fig. 2 *k* with the exception of the first, this being hidden by the lateral wings of the preceding segment. The very short basal joint of the peduncle of each of the pleopods has on the outer side a small organ, looking outwards and at least sometimes a little downwards. Each uropod has one organ on the peduncle, situated on its inner surface near the lower margin and close to the base, besides one organ on the interior (lower) surface of the inner branch near its base; finally, two organs on the interior (lower) surface of the outer branch, one of them near the middle and the other on the distal narrowing part.

From the preceding description it is seen that most of the organs look downwards, a smaller number somewhat outwards or forwards, rather few almost totally outwards, and none upwards, with the exception of one on the first maxilliped. With the exception of the few lateral organs on the scutum, all the others are found on or near the lower surface of the body and on the appendages.

The structure of the organs is very interesting, and very different from all hitherto known in any invertebrate animal. I have examined more closely three organs, viz., that situated on the third joint of the first maxilliped, one of the "stalked" organs near br. above trl.[3], and one from the antero-inferior margin of the fourth abdominal segment. The two last-named organs have been cut off, most of the adhering tissue removed by dissection, and the organs examined with moderately high magnifying power. I have found no difference of any importance between the three organs from such distant parts of the animal's body.

The organ taken as type is that from the infero-lateral margin of the thorax; it has been drawn (fig. 2 *m*) in optical vertical section. The skin forms a chitinous, large, and very thick biconvex lens (*a*), which is vitreous and a little yellowish; the major central part is covered by a rather thin limpid layer (a^1), but this layer I could not perceive on the two other organs examined. The lens is circular in outline; its diameter is about two-thirds as long as that of the inner portion of the organ at its thickest part. The inner side of the biconvex lens is covered by a large and rather thick concavo-convex lens (*b*), which is somewhat thinner than the outer lens, but with the diameter a little longer than that of the same; the lateral margin of the inner lens is oblique, very broad, touching the external chitin around the outer lens. This inner lens, which consists of two layers, is homogeneous, vitreous, and slightly greyish; but the difference between the colour of the outer and the inner lens is in the figure purposely a little more strongly marked than in nature. These two lenses remind one of optical instruments in which the lens is

composed of crown-glass and flint-glass. Behind the inner lens is found a thick layer of glandular cells (*d*), which are light greyish, very large, and most of them elongate, radiating towards the centre of the outer lens. The diameter of this layer is somewhat larger than that of the inner lens; and when the luminous organs are examined in their natural position with a strong pocket-lens, this layer can often be seen through the skin as a whitish ring around the lens. Between the layer of large cells and the inner lens a thin layer (*c*) seems to exist, but its quality could not be made out, and I do not venture to propose any hypothetical explanation. Behind the glandular layer is seen another (*e*), which is yellowish, with numerous transverse fine stripes, and without trace of cellular structure; it is rather thick in the middle, but thin around the sides of the glandular layer. The internal surface of the organ seems to be covered by a thin layer (*f*) of connective tissue. That the posterior layer with the transverse stripes is—as in the Euphausiidæ—a reflector can be taken for granted. But it is impossible to decide whether the light is produced by the glandular layer or by the inner lens. Whether the thin layer enveloping the whole organ is pigmented or not cannot be seen on this old material, which has been preserved twenty-eight years in spirit; that the organs are immovable scarcely needs to be stated. Future investigation of living animals and of sections of fresh material must elucidate whether the organs are especially innervated or not, and, besides, fill up the other gaps in the interpretation of the function and structure of the layers in these compound structures.

A brief comparison of the luminous organs in *Sergestes challengeri* with those in other Crustacea is not without interest. Of animals belonging to that class, luminosity has been observed in some Copepods, a few Ostracods, Euphausiidæ, and one macrurous Decapod. Giesbrecht has published a thorough and interesting study: "Ueber das Leuchten der pelagischen Copepoden und das thierische Leuchten im Allgemeinen" (Mitth. zool. Stat. Neapel, 11 B., 1895, pp. 648–689). He has examined a small number of pelagic Copepoda—necessarily restricting himself to all the luminous forms which he could procure in a living state in the Gulf of Naples—showing that these animals possess a number of small dermal glands, the secretion of which produces the luminosity when it, by exhaustion from the glands, comes in contact with the surrounding water. In a few Ostracoda a brilliant luminosity is produced in a similar way from glands in the labrum; it was already suggested by G. W. Müller in 1890, and has since been observed and published by another author. Furthermore, I can mention that during a voyage in the Indian Ocean, Dr. Th. Mortensen met with a vast number of a pelagic Ostracod which showed a most brilliant light, and he observed how this was produced. Finally, the present writer has observed nearly the same in a number of a large Ostracod which had been procured in Davis Strait. Late in the evening I observed

luminous points in recently sieved bottom material from 318 fathoms, and undertook instantly some manipulations with the animals: the luminous fluid came from the head, probably from the large labrum, and flowed backwards between the shells, illuminating brilliantly the space between them, especially on the ventral side. As to the Entomostraca, we can therefore not speak of "luminous organs" in the common sense of the word, the light being always produced in the above-described way.

In almost all Euphausiidæ real and highly-developed luminous organs are found, but they differ in structure very much from those in *Serg. challengeri*. The reader is referred to Sars's Report on the 'Challenger' Schizopoda, and to Chun, "Leuchtorgane und Facettenaugen" (Bibliotheca Zoologica, Heft xix. Lief. 4, 1896). The highest number of organs met with in this family is only ten: one on each eye-stalk, two on each side of the thorax near its inferior margin, and one in the median line of each of the four anterior abdominal segments. The light is produced by the "Streifenkörper" (Chun)—"a flabelliform bunch of exceedingly delicate fibres, exhibiting in fresh specimens a most beautiful iridescent lustre" (Sars, *op. cit.* p. 71)—situated a little behind the centre of the organ in a mass of large cells; a biconvex lens, which is present in the organs with the exception of those on the eye-stalks, is internal, while the outer chitinous skin is thin; a reflector is developed nearly as in *Sergestes*.

The Danish zoologist Cand. mag. Ad. S. Jensen has directed my attention to a book by a French author, and lent me a German translation: 'Die Leuchtenden Tiere und Pflanzen. Von Henri Gadeau de Kerville. Aus dem Französischen übersetzt von W. Marshall, 1893.' In this popular treatise I saw that the 'Talisman' had captured a deep-sea shrimp with numerous luminous organs. I attempted in the 'Zoological Record' and elsewhere to discover where that animal had been described, but in vain, and I will therefore reprint the passage in question from the German book:—"Während der wissenschaftlichen Expeditionen des Talisman fing man in einer Tiefe von 500 m. einen langschwänzigen Krebs (*Acanthephyra pellucida* A. Milne-Edwards), welcher ein lebhaftes Licht um sich zu verbreiten im stande war und zwar mittels folgender verschiedener Leuchtorgane; erstens befand sich eins am Vorderrand einer Deckschuppe der Augen, zweitens verlief eine lange leuchtende Linie am Aussenrand des Tarsus des fünften Beinpaares, an dessen innern Basis sowie an der des vorhergehenden Beingliedes sich weiter leuchtende Flecke befanden, drittens lagen ganz ähnliche Flecke an der Basis des zweiten Gliedes des dritten und vierten Beinpaares und ebenso je einer an der Basis des Tarsus derselben Gliedmassen, viertens sah man einen langen Fleck an der Basis am Endgliede des hintersten Kieferfusspaares, fünftens verlief ein schimmerndes Querband über die Hüfte des hintersten Thorakalfusspaares, sechstens war eine Doppelreihe glänzender Punkte an jedem Gliede der Aussengeissel der Brustfüsse, sowie an dem äusseren Blatt der Bauchfüsse vorhanden, siebentens zeigte sich

eine doppelte Linie leuchtender Punkte entlang der äusseren Geissel der Innenfühler und achtens verlief eine im hinteren Teile zusammenhängende, im vorderen in Punkte aufgelöste Linie parallel zum Unterrande des Rückenpanzers." The arrangement of the organs in *Acanthephyra pellucida* is rather different from that in *Sergestes challengeri*, but it shows yet more resemblance to it than to that in the Euphausiidæ. Both in *S. challengeri* and in *A. pellucida* an astonishingly high number of organs exist, but as to the structure of the organs in the last-named form unfortunately nothing is known. I suppose that they are real compound organs, not dermal glands as in the Entomostraca.

If we look for comparison between all luminous animals, it will be found that only some deep-sea or pelagic fishes and two Cephalopoda of the genus *Histioteuthis* (according to Verany and Joubin) possess a number of real organs which can be compared with that found in *Serg. challengeri* and *Acanth. pellucida*.

I have looked for luminous organs in all adult species of *Sergestes* known to me and in *Acanthephyra purpurea* A. M.-Edw., but the result was absolutely negative. It is a very curious fact that about 150 very compound organs are found in one species of *Sergestes*, while they seem to be quite absent in all other species hitherto known of the genus. It may be added that the luminous species does not deviate from some of the other forms in any other character of importance: it belongs, even within the genus, to a group which contains several deep-sea forms closely allied to each other. Considered in this light, the existence in one species of about 150 compound organs seems to me a most astonishing feature.

Supplementary Note.

In the preceding section it has been mentioned that among the Cephalopoda two species of *Histioteuthis* possess a large number of compound luminous organs. My friends Prof. G. B. Howes and Rev. Th. R. R. Stebbing have very kindly directed my attention to two papers, which contain some additional knowledge of the same topic and may be quoted here. W. E. Hoyle (Mem. & Proc. of the Manchester Liter. & Philos. Soc. vol. xlvi. part vi. 1902) points out and describes the structure of twenty-nine luminous organs in *Pterygioteuthis margaritifera*, but this number, though rather high, is yet considerably lower than that in *Sergestes challengeri*. C. Chun ('Aus den Tiefen des Weltmeeres,' Jena, 1900) describes and figures (p. 532) the arrangement and the colours of twenty-four luminous organs in "*Enoploteuthis diadema* Ch., n. sp." Furthermore, he writes (pp. 532–33): "Ähnliche, wenn auch etwas kleinere Organe, besetzen bei Vertretern der Gattung *Calliteuthis* die ganze Körperoberfläche von den Armen bis zu den Schwanzflossen. Die Bauchseite ist auch hier wieder reichlicher mit ihnen ausgestattet, als die Rückenfläche." An accompanying figure of a "*Calliteuthis* n. sp.," seen from the ventral side, shows a number of organs considerably surpassing that in *Serg. challengeri*.

EXPLANATION OF THE PLATES.

PLATE XI.

1. *Petalidium foliaceum* Bate. p. 54.

Fig. 1 *a*. Rostrum of a specimen from Stat. 159, from the side.
1 *b*. Eye and left antennular peduncle of the same specimen, from above.
1 *c*. Rostrum of a specimen from Stat. 146, from the side; × 5.
1 *d*. Eyes of the same specimen, from above; slightly more than × 5.
1 *e*. Basal part of mxp.^{2}—mxp.^{3} and trl.^{1}—trl.^{3}, together with the branchial apparatus of the last-named specimen; × 5. *br*., rudimentary pleurobranchia to mxp.^{2}; *ep*., epipod on mxp.^{2} with its branchia; *l*., four pleurobranchial lamellæ belonging to mxp.^{3} and trl.^{1}—trl.^{3}
1 *f*. Lateral view of the front part of the scutum and the eye of a young specimen—measuring 21·5 mm. in length—from Stat. 158.
1 *g*. Rostrum and eyes of the same specimen, from above.

2. *Petalidium* sp. p. 55.

Fig. 2 *a*. Front portion of the scutum of a young specimen from Stat. 137, described by Bate as *Sergestes profundus* Bate.

3. *Sergestes profundus* Bate. p. 69.

Fig. 3 *a*. Front part of the scutum, eye, and antennular peduncle of the specimen from Stat. 300; × 15/2.
3 *b*. Rostrum of the same specimen.

4. *Sergestes prehensilis* Bate. p. 56.

Fig. 4 *a*. Rostrum, eye, and base of the antennular peduncle, from the side.
4 *b*. Front end of the scutum, eyes, peduncles of the antennulæ and squamæ, from above.

5. *Sergestes kröyeri* Bate. p. 58.

Fig. 5 *a*. Rostrum, from the side.
5 *b*. Front end of the scutum, left eye, and the peduncles of the antennulæ, from above; × 4.

6. *Sergestes similis*, n. sp. p. 60.

Fig. 6 *a*. Front end of the scutum, left eye, and peduncle of the antennula, from the side; × 14/3.
6 *b*. Rostrum and supra-ocular spine, from the side; × 12.
6 *c*. Front end of the scutum, eye, peduncles of the antennulæ and squamæ, from above; × 5.
6 *d*. Branchiæ above trl.^{2}—trl.^{4}; × 11/2. *2 br*., first branchia to trl.^{2}; *2 l*., branchial lamella to trl.^{2}; *3 br*., first branchia to trl.^{3}; *3 br*.^{1}, second branchia to trl.^{3}; &c.

PLATE XII.

1. *Sergestes arcticus* Kr. p. 60.

Fig. 1 *a*. Front end of the scutum, eye, and basal portion of the antennular peduncle, from the side; × 9/2.
1 *b*. Rostrum and supra-ocular spine of the same specimen; × 11.
1 *c*. Branchiæ above trl.^{2}—trl.^{4}; × 8. The lettering as in fig. 6 *d* on the preceding Plate.

2. *Sergestes challengeri*, n. sp. p. 61.

In the following figures *o* signifies luminous organs.

Fig. 2 *a*. Scutum, with the basal parts of the eye-stalk, antennula and antenna; × 5.
2 *b*. Front end of the scutum, basal part of the eye-stalk, and antennular peduncle; × 17/2.
2 *c*. Front end of the scutum with the anterior appendages, from above; × 9. Of the eye-stalks only the basal joint remains; of the left squama the distal half is omitted; on the right squama the two distal ones of the four luminous organs are seen through the plate.

Fig. 2 *d*. The basal parts of the three posterior thoracic legs, the branchiæ above trl.^{2}—trl.^{4}, and the lower part of the two anterior abdominal segments, from the side; × 11. The lettering of the branchiæ as in fig. 6 *d* on the preceding Plate.

2 *e*. Left mandible, from below; × 13.

2 *f*. Left first maxilliped, from below; × 13.

2 *g*. Middle part of the first maxilliped, from above; × 44. o^1, upper proximal luminous organ; o^2, distal luminous organ seen through the endopod.

2 *h*. Left second maxilliped with its epipod and branchia, from the outer side; × 13.

2 *i*. The three posterior thoracic segments and the two anterior abdominal segments, from below, showing 31 luminous organs; × 9. Of the pleopods, only the basal joint—with its luminous organ—has been drawn.

2 *k*. Sixth abdominal segment with the basal part of the telson and the uropods, and the posterior part of the fifth abdominal segment with a part of the pleopod; × 13/2.

2 *l*. Exterior branch of the left uropod, from the outer side; × 17/2. The apical part is wanting.

2 *m*. Luminous organ from the side of the thorax near *br*. above trl.^{3}, seen in optical vertical section; × 180. *a*, chitinous lens; a^1, its thinner external layer; *b*, inner lens; *c*, thin layer between the inner lens and the thick glandular layer *d*; *e*, reflector; *f*, enveloping thin layer.

2 *n*. Sketch of the luminous organ from the upper side of the first maxilliped; × 180. *a*, lens, partly overlapped above by the protruding chitinous plate *l*.

February 3, 1903.

Howard Saunders, Esq., F.L.S., Vice-President, in the Chair.

The Secretary read the following report on the additions to the Society's Menagerie during the month of January 1903:—

The registered additions to the Society's Menagerie during the month of January 1903 were 58 in number. Of these 15 were acquired by presentation and 9 by purchase, and 34 were received on deposit. The total number of departures during the same period, by death and removals, was 120.

The following papers were read:—

1. Notes on the Hair-Slope of four Typical Mammals.

By Walter Kidd, F.Z.S.

[Received November 27, 1902.]

The Otter, Domestic Dog, Ox, and Horse have been selected for consideration as showing very different arrangements of their hairy coverings, and as affording by their environments and habits the probable explanation of the differences found. Two Carnivores and two Ungulates are thus compared and contrasted.

(1) In the Otter, taken as a type of the long-bodied hairy mammal with very short limbs, the hair presents an unbroken slope from the snout to the tip of the tail. On the head and

trunk it passes from cephalic to caudal, and on the limbs from proximal to distal extremities in a perfectly uniform manner. This arrangement obtains in a great number of long-bodied or primitive forms, such as rodents, smaller carnivores, insectivores, marsupials, lemurs and lower monkeys. As to the hair-slope in the Otter, nothing further requires notice, and the type may be looked upon as that of the primitive hairy mammal.

(2) When a Carnivore of a different form, such as a short-bodied close-haired Domestic Dog, is investigated, a few departures from the primitive type of hair-slope are found. The Dog is taken as representing a more highly developed carnivore form, and it presents, as do all Canidæ possessing sufficiently short hair:—

(i) A whorl situated at the extremity of the snout with a feathered arrangement proceeding from it towards the orbits.

(ii) Reversed bilateral area of hair on the pectoral region.

(iii) Reversed bilateral area of hair on the ventral surface of the abdomen in the inguinal region.

(iv) Bilateral symmetrical whorl in the gluteal region lying exactly over the tubera ischii, and, proceeding towards this spot, a reversed area of hair on the extensor aspect of the thigh.

(v) Reversed area of hair on the extensor surface of the ulna.

These have been fully described, and explanations of their ætiology put forward, in our Proceedings [1].

The Domestic Dog thus presents an advance in several directions upon the primitive arrangement of hair in the Otter.

(3) The Domestic Ox shows certain peculiarities and departures, both from the primitive and specialized Carnivore type:—

(i) In the frontal region a whorl and a feathering which proceeds from it towards the level of the external ears, terminating here in a crest.

(ii) Short longitudinal crest or mane, commencing as a tuft at the level of the horns.

(iii) This crest or mane is interrupted abruptly in its normal backward course at about the middle of the neck by a ridge. At this point there is produced a meeting of two streams of hair proceeding in opposite directions, and the forward or "abnormal" stream is found to commence at a whorl which lies in the median plane at about the middle of the dorsal region.

(iv) From the whorl situated on the dorsal region the slope of hair resumes its normal direction and passes to the tail, on which it is so arranged that a central longitudinal crest is usually found, and it terminates in a scanty tuft of hair.

[1] Proc. Zool. Soc. 1902, vol. ii. pp. 148, 149, 150.

The Ox presents no pectoral whorl as do the Dog and Horse, the dewlap in this region being covered with perfectly smooth and uniformly arranged hair.

These are the only four constant peculiarities of hair-slope, but occasionally the flank and post-humeral regions, and extensor surface of the thigh, show small whorls and featherings connected apparently with the action of the panniculus carnosus muscle.

(4) The Horse is more specialized in the matter of hair-slope than any other animal except man.

It shows constantly—

(i) Frontal whorl, feathering, and crest.
(ii) Tuft between the external ears.
(iii) Longitudinal crest or mane.
(iv) Strong efficient tail with bushy hair, reaching to the fetlock.
(v) Inguinal whorl, feathering, and crest.
(vi) Pectoral whorl, feathering, and crest.

Frequently but not constantly:—

(vii) Post-humeral whorl, feathering, and crest.
(viii) Cervical whorls, featherings, and crests in several situations.
(ix) Gluteal whorl, feathering, and crest.
(x) Tuft on lateral aspect of the abdomen.

In passing from the simple type found on the Otter to that of the Horse, a very significant series of changes is thus displayed.

Such facts as are here referred to have little or no intrinsic interest or importance, but the phenomena of Nature, small and great, demand explanation in accordance with the methods of science, and it is impossible to ignore the peculiarities of hair-slope which have been taken here as typical of a vastly greater number in other animal forms. Any other interest they may have is subordinate to their relation to the problems of heredity. The four groups of facts suggest apparently two explanations as to their ætiology. The first and most obvious is that some of them are adaptive modifications of value to the animal; the second, that others are produced by its habits; and it is not difficult to distinguish these two classes in the four typical forms chosen for consideration.

1. In the Otter the uniform trend of hair requires no other explanation than that this arrangement of hair offers the least possible resistance to movements in the water and in burrows.

2. In the case of the Domestic Dog the departures from a primitive type can hardly be ascribed to anything else than to use or habit: they are adapted *by* the habits of the animal, not *for* its needs.

3. The Domestic Ox presents certain points of interest intimately associated with adaptive modifications, but many of the phenomena are evidently not so associated. Thus, along the median line of the dorsal aspect of the Ox is seen a tuft, crest or mane, whorl, and long efficient tail, the length of the last being such as to reach beyond the dorsal whorl. The large hairy external ears, which can be flapped backwards so as nearly to reach the middle line, may also be included. These may be looked upon as adaptive modifications, existing for the purpose of defending the animal against injurious insects; and a few observations on several oxen and horses have been made as to the importance and frequency of these, and as to the use of the panniculus carnosus, even in this temperate climate.

In moderate summer weather and an exposed wind-swept situation, the number of occasions on which certain oxen and horses flapped backwards and forwards their ears, corrugated their skins by the action of the panniculus, and flicked their tails on to their backs was observed and noted with the following results:—

Tails flicked by oxen at the rate of 348, 468, 504, 540, 720, 780, 1082 times in an hour.

Ears flapped by oxen at the rate of 684, 816, 840 times in an hour.

Panniculus acted in oxen at the rate of 984 times in an hour.

Tail flicked by horse at the rate of 1108 times in an hour.

A rough idea may thus be gained as to the importance of certain of these mechanisms for defence against injurious insects in hot countries, if in a temperate climate and exposed situation so frequent a use is made of them.

4. The Horse also presents in the median plane several similar modifications, as a tuft, mane, and long bushy tail, which, when not docked, reaches almost exactly to the spot where the mane terminates. The panniculus in the Horse is much more active in that part of the flank and in the forequarters where the tail does not reach than elsewhere.

It remains only to point out the distinction maintained here between modifications of hair-arrangement which are themselves adaptive, as in the Otter, and others which are, so to speak, by-products of habits of the animals exhibiting them, such as whorls, featherings, and crests. The only meaning properly assigned to adaptive modifications is that such modifications are adapted for the needs or comfort of an animal. When they are adapted *by the habits* of an animal, and have no thinkable relation to its needs, they must be classed strictly as non-adaptive phenomena.

It should be further stated that all the phenomena referred to are congenital, and would seem to have an intimate connection with the problems of heredity.

List I.

Otter.....	No modifications of primitive type of hair-slope.	
Dog	2 whorls &c.	
	3 reversed areas of hair.	
Ox	2 whorls &c.	
	Tuft and small mane.	
	Crest and tuft on tail.	
Horse ...	3 whorls &c.	Constant.
	Tuft.	
	Mane.	
	Bushy tail.	
	4 whorls &c.	Occasional.

List II.

	Departures from Primitive Hair-slope.	*Phenomena of Hair-arrangement, adaptive or non-adaptive.*	*Environments.*	*Habits.*
Otter...	None.	All adaptive.	Homogeneous.	Simple.
Dog.....	5	All non-adaptive.	More varied.	More varied.
Ox	4 constant, several occasional.	1 non-adaptive. 3 adaptive. Non-adaptive.	Still more varied.	Still more varied.
Horse..	6 constant, 4 occasional.	3 non-adaptive. 3 adaptive. Non-adaptive.	Most varied of the four types.	Complex, combining the habits of its wild life with those of domestication.

List III.

Observations as to use of External Ears, Panniculus Carnosus, and Tail in Ox and Horse.

Oxen flapped external ears at the rate of.....	684,816,840 times an hour.
In Oxen panniculus acted at the rate of	984 times an hour.
Oxen flicked tails at the rate of	348, 468, 504, 540, 720, 780, 1082 times an hour.
Horse flicked tail at the rate of	1108 times an hour.

2. A Prodromus of the Snakes hitherto recorded from China, Japan, and the Loo Choo Islands; with some Notes. By Captain F. Wall, Indian Medical Service.[1]

[Received December 15, 1902.]

Whilst attached to the China Expeditionary Forces from 1900–1902, I had opportunities of examining the Snakes preserved in the three Museums in China, and also others in private collections. My notes on these, together with those on specimens obtained myself, form the subject of this paper, which I have arranged so as to form a complete prodromus of the species hitherto recorded from the countries above specified.

In spite of the large aggregate of specimens I examined, it is perhaps worthy of remark that I failed to discover one species new to science[2], and this only serves to show how extensively and thoroughly this branch of natural history has been worked out.

In the City Hall Museum in Hongkong, out of about one hundred specimens from the territory above mentioned, I found many misnamed and others unidentified. I was informed that during a typhoon some years previously a large case, containing specimens, was blown over and the contents wrecked. Out of the débris labels were recovered as far as possible and replaced, but some were evidently incorrectly reattached and others were destroyed. This circumstance may render the accuracy of some of the records open to question. That this collection is far from representative is evidenced by the fact that during five and a half months' residence in this Port I obtained six species which were not to be found in the Hongkong Museum.

In the Museum in Shanghai I found about fifty specimens which were for the most part old, and concerning which there was practically no information regarding their habitat.

In the Museum belonging to the Jesuit Fathers at Siccawei, near Shanghai, I examined some two or three hundred specimens, but these, again, furnished practically no record of their habitat; however, the late Père Heude informed me that they had all been collected in the Yangtse Valley, and he mentioned Ning-ko-foo (which I find is on the southern bank of the Yangtse River) as being the most northern limit. He could not define limits either to the south or west.

As regards habitat, where I do not cite the authority, so far as the territory this makes reference to is concerned, it is to be understood that examples exist in the British Museum Collection at South Kensington.

I have only made reference to points in these specimens which do not absolutely agree with the descriptions to be found in

[1] Communicated by G. A. Boulenger, F.R.S., V.P.Z.S.

[2] The species referred to hereafter as *Dipsadomorphus kraepelini*, No. 65, which I had hoped to have the honour of describing for the first time, was recorded by Stejneger shortly after I began to prepare this paper.

Mr. Boulenger's work 'Catalogue of Snakes in the British Museum,' 1893–1896, and I have also adopted the nomenclature of that work.

I am indebted to Mr. Boulenger for much valuable information and assistance in drawing up this synopsis. My thanks are also due to Mr. F. Bowley, Hongkong, Dr. Barchet, Shanghai, and the late Père Heude, Siccawei, for their courtesy in granting me access to the collections in the Museums under their superintendence, as well as to Mr. A. Owston, Yokohama, and Mr. Armstrong, Hongkong, for placing their specimens at my disposal.

Part I.—List of Chinese Ophidia.

Typhlopidæ.

1. Typhlops lineatus. Malay Peninsula and Archipelago, Hongkong?

2. Typhlops braminus. Southern Asia from Arabia to Malay Archipelago, South China, Formosa, Hongkong, Hainan, Mauritius, Comoro Islands, Madagascar, Cape of Good Hope.—I obtained one small specimen three and a half inches long on the Peak in Hongkong Island.

Boidæ.

3. Python reticulatus. Burma, Indo-China, Siam, Malay Peninsula and Archipelago, S. China, Hongkong (*City Hall Mus.*).—I saw three specimens, one in the City Hall Museum, Hongkong, labelled from that island, one in the Shanghai Museum, habitat unrecorded; and one in the Siccawei Museum, consisting of a head only. From the information given by the late Père Heude concerning this collection, I must include this species among the Chinese fauna. In all the specimens there are three rows of præfrontals, and the lower labials from the 2nd to 4th and from 13th to 18th are pitted. The frontal is divided longitudinally in two of the specimens. Ventrals 315–319. Subcaudals 92–100.

4. Python molurus. Southern Asia from India to China, Hainan, Hongkong (*City Hall Mus.*), Formosa (*Swinhoe*).—The Chinese name given me was "Hiang zo," or "aromatic snake," perhaps in reference to their cooked flesh, which is highly esteemed by these people. In Formosa it is called "Uang" (*Swinhoe*).

Colubridæ.

5. Acrochordus javanicus. Malay Peninsula, Java, New Guinea, Hongkong (*City Hall Mus.* No. 293).

6. Polyodontophis collaris. Himalayas as far west as Simla, Assam, Arrakan, Upper Burma, S. China, Hongkong.—I obtained one specimen on Hongkong Island. There is one anterior

temporal on both sides, which comes in contact with the eighth labial only; this latter is unusually high and is probably the result of a confluence with the normal inferior anterior temporal. The first lower labials do not meet behind the symphysis. Belly unspotted.

7. Tropidonotus swinhonis. Formosa.

8. Tropidonotus nuchalis. China.

9. Tropidonotus vibakari. Manchuria, Japan, Formosa.

10. Tropidonotus piscator. Southern Asia from India to China, Hainan (*Herz & City Hall Mus.*), Hongkong (*Hallow. & City Hall Mus.*), Formosa (*Stejneger*).—Apparently common in the extreme south. I obtained three specimens from the mainland opposite Hongkong, and saw one in Mr. Armstrong's collection which he assured me he procured from Hongkong Island. I found only two specimens in the large Siccawei Collection. In one specimen (from Kowloon, opposite Hongkong) there are five postoculars on one side, in another four on both sides. In one there are eight upper labials, with the fourth only touching the eye on both sides.

11. Tropidonotus annularis. China, Formosa.—This must be a very common snake in the Yangtse Valley, judging from the large number of specimens in the Siccawei Museum, but in the extreme south it appears to be rare or absent. There are two præoculars on both sides in one specimen, five postoculars on both sides in one specimen, and two postoculars on one side in one specimen. Ventrals 132–164. Subcaudals 70 in one specimen.

12. Tropidonotus tigrinus. Siam, Cochin China, China, Hainan, Hongkong? Manchuria, Corea, Japan.—Called "Yeh-chi-po" by the Chinese, signifying pheasant's neck, also "Ch'ing-ch'ang-chung (*Möll.*). Apparently as common as *T. annularis* in the Yangtse Valley, from the number of specimens at Siccawei. One specimen in Mr. Armstrong's collection was, he informed me, captured on Hongkong Island; however, it was not labelled, and his collection contained some species he had procured in Japan.

13. Tropidonotus stolatus. Southern Asia from India to China, Hainan, Hongkong, Formosa, Chusan Archipelago, Philippines.—I obtained one specimen from the mainland opposite Hongkong. The labials on one side were nine in number, and the fourth, fifth, and sixth touched the eye. I saw no specimen in the Shanghai or Siccawei Collections.

14. Tropidonotus subminiatus. Eastern Himalayas, Assam, Burma, Malay Peninsula and Archipelago, S. China, Hongkong.

15. Tropidonotus chrysargus. Eastern Himalayas, Assam, Burma, Malay Peninsula and Archipelago, S. China, Hainan.

16. Tropidonotus balteatus (Cope), Proc. Ac. Philad. 1894, p. 426. Hainan.

17. Tropidonotus craspedogaster (Blgr.), P. Z. S. Lond. 1899, p. 163, pl. xvii. fig. 1. China.

18. Tropidonotus percarinatus (Blgr.), P. Z. S. Lond. 1899, p. 163, pl. xvii. fig. 2. China.—I saw six specimens in the Siccawei Collection which exactly fit the description of Mr. Boulenger's specimen except in the following details:—Length of internasals sometimes equals præfrontals. Postoculars and suboculars: the numbers of shields in contact with the back of the eye, intervening between the supraocular above and the fifth labial, are four in two specimens on both sides, four in one specimen on one side, five in two specimens on both sides, five in two specimens on one side, six in one specimen on one side. Labials eight with third and fourth touching the eye on one side, nine with fifth only touching the eye on one side. Ventrals and subcaudals 140+73, 139+ ?, 139+73, 138+ ?, 138+72 (tip slightly docked).

19. Tapinophis latouchii (Blgr.), P. Z. S. Lond. 1899, p. 164, pl. xviii. figs. 1–1 *c*. China.

20. Pseudoxenodon macrops. Himalayas, Khasi Hills, Hills in Burma, Yunnan (*de Scabra*[1]), and S.W. China.

21. Pseudoxenodon dorsalis. China.

22. Opisthotropis andersonii. Hongkong.—I obtained five specimens, all from Hongkong Island. They were all captured in a swamp near the Sanatorium on the Peak, whilst being drained during the campaign against malarial mosquitoes. One was dug up at a depth of about 2 feet below the surface. They accord with Mr. Boulenger's description except in the following particulars:—Labials are inconsistent in arrangement. There are nine in one specimen on one side, eight in all the rest. The fourth and fifth touch the eye in one specimen on one side, the fifth only touches the eye in two cases on both sides, and in one case on one side, no labials touch the eye in two specimens on one side. Præoculars (including the suboculars of Boulenger) are two in two specimens on both sides, two in two specimens on one side, one in one specimen on one side, and three in one specimen on one side. The anterior chin-shields are in contact with five lower labials in two specimens on both sides, and in one specimen on one side, with four in one specimen on both sides, and in one specimen on one side. Ventrals and subcaudals 167+60, 149+53, 164+59, 165+59. Colour uniform dull olive-bluish above, lower half of ultimate row and belly yellow. Lower labials and throat-scales with dull bluish mottling. Sparse mottling beneath tail.

[1] Bull. Mus. H. N. Paris, 1897, iii. p. 215.

23. Trirhinopholis styani (Blgr.), P. Z. S. Lond. 1899, p. 164, pl. xviii. figs. 2 & 2 *a*. China.

24. Achalinus rufescens. Hongkong.—I obtained four specimens in Hongkong Island, found in the low vegetation on the slopes of the Peak. In one specimen both anterior temporals touch the eye on both sides. Scales somewhat irregular, 23–25 in mid-body. Ventrals and subcaudals 150+56, 158+58, 158+61, 154+58. Colour uniform olive-brown above, slightly darker vertebrally, and with iridescence in reflected light. Head same colour above, merging to chestnut on temporal regions.

25. Achalinus bracconieri. S. China.—I think that this species will have to be united with *A. spinalis*; the differences between the two shown by Mr. Boulenger[1] are considerable but not constant, being shared by individuals of both supposed species. For instance, in all the four specimens of *A. spinalis* that I have examined (one of which I presented to the British Museum, which has been seen and identified as such by Mr. Boulenger) the scales are 23, and not 21. The relative length of the sutures between the internasal and præfrontal has, in my opinion, little or no weight. The specimen of *A. spinalis* I sent to the British Museum has the internasal suture about two-thirds the length of the præfrontal; and in more than one specimen of *bracconieri* in the British Museum a similar condition exists. The specimen figured by Stejneger[2] from Japan which he calls *spinalis* is more like Mr. Boulenger's *bracconieri*, but has 23 scales.

26. Achalinus spinalis. China, Japan.—I saw three specimens in Mr. Owston's collection from Mount Fuji, Japan, and one I found in the Siccawei Collection. In all there is a large shield on the postero-lateral region of the parietals similar to those described under *A. bracconieri*, and, like them, separated by one scale in the median line. Ventrals and subcaudals 154+58, 165+44, 165+48, 170+44.

27. Lycodon aulicus. Southern Asia from India to Malay Archipelago, Philippines, Formosa (*City Hall Mus.*), Hongkong? (*Boettger*[3]), S. China? viz. from Amoy (*Steindachner*[4]).

28. Lycodon fasciatus. W. Yunnan (*Anderson*), Assam, Burma.

29. Lycodon subcinctus. Malay Peninsula and Archipelago, Sumatra, Borneo, Java, Timor, Hongkong, Philippines.—There are two specimens in the City Hall Museum from Hongkong and one from Timor. I also examined a fourth, which Mr. Armstrong

[1] Cat. Snakes Brit. Mus. vol. i. pp. 308 & 309.
[2] Ann. Zool. Japon. ii. p. 29.
[3] The specimen alluded to by Boettger (Mat. herp. Faun. von China, 1888, p. 84) in the City Hall Museum is no longer in the collection; the only specimen of this species in that Institution is from Formosa.
[4] Reise der Novara, Rept., Wien, 1869, p. 74.

informed me he had captured in the filter-beds near Bowen Road on Hongkong Island. In two specimens the third, fourth, fifth, and sixth supralabials touch the eye on both sides. Ventrals 192–209[1].

30. Dinodon rufozonatus. China, Hainan, Formosa, Chusan, Corea, Tsu Shima, Japan, Loo Choo Islands.—This is a very common snake about Shanghai, where I encountered it frequently. I picked up several and allowed them to crawl about my arms without their exhibiting the least malice or alarm, and they made little attempt to escape in the first instance. Riding my bicycle one night I saw one crossing the road; I dismounted, flashed my lamp on the snake, and, while holding my machine with my right hand, captured it easily with my left. It made no attempt at escape, though cover was within a yard or two. It was full-grown and not desquamating. My servant caught one in camp one night just outside my hut; it encircled the man's leg but did not bite. It contained a large toad (*Bufo vulgaris*). I found a large number preserved in the Siccawei Museum. I found one in Mr. Owston's collection obtained from Japan, and four others procured from Ishigaki Island in the Loo Choo group. I noted the following:—Internasals half or less than half the length of præfrontals. Loreal, in Japanese and Loo Choo specimens, does not touch the eye in all (five); in Chinese does not touch the eye in five, touches eye in eleven. Postoculars three on both sides in one specimen, three on one side in one specimen. Temporals one on one side in one specimen. Labials normal in all. Anterior chin-shields in contact with four lower labials in one specimen on both sides, with six lower labials on one side in two specimens. Ventrals in Japanese and Loo Choo specimens 180–190; in Chinese specimens 192–209. Subcaudals in Japanese and Loo Choo specimens 76–87; in Chinese specimens 64–76. Colour: there appear to be two very distinct varieties. All the Chinese conform to the following description:—Alternate bars of jet-black and coral-red (white in old spirit-specimens) dorsally, breaking into a coarse mottling on the flanks. The black bars involve two or three scales in the length of the snake, and the red one scale or slightly more. There are 53–74 black bars on the body and 18–24 on the tail, the first is broadest and forms a chevron on the nape. Head black, fading to whitish on labials; sutures on crown coral-red. A light temporal streak usually. Belly whitish, with some lateral mottling. The Japanese and Loo Choo specimens agree:—Alternate darkish-brown and dirty whitish (perhaps red when fresh) bars dorsally, breaking up into a mottling laterally. The brown bars involve four or five scales (more quite anteriorly), the light one scale. There are 24–33 brown bars on body, 15–18 on tail. Crown of head brown, fading

[1] Günther records also *Lycodon* (*Ophites*) *albofuscus* from Formosa (Ann. Mag. Nat. Hist. (4) vol. i. 1868, p. 426), but gives no description nor authority for recording it.

to whitish on labials. A light temporal streak. Belly whitish, with or without sparse lateral mottling, except beneath tail where this is abundant.

31. Dinodon septentrionalis. China, Formosa, Himalayas ?

32. Zaocys dhumnades. S. China, Chusan.—A very common snake about Shanghai and evidently throughout the Yangtse Valley, for there are many specimens in the Siccawei Museum. I have encountered it frequently, and consider its generic name most apt, as it is very active, swift, and clever to elude capture. I saw as many as four in a day's ramble in the spring, when batrachians were clamouring in the water engaged on matrimonial matters. The snakes were each coiled up on the banks close to the water, and in low vegetation, awaiting the excursion of some unwary individual. One I saw coiled up similarly two yards or so away from two toads (*Bufo vulgaris*), whose curious behaviour it was that first attracted my attention. In spite of every care my presence was always detected by the snake before I was aware of its presence, and it immediately made off in great haste for the water, and disappeared among the roots of the aquatic vegetation. On one occasion in the summer I watched one for some time in a strip of grass in the open, myself unobserved; and it was most interesting to notice the method and care with which it beat the patch of grass like a harrier, prying into every recess in the ground or tussock that might harbour some possible prey. I have seen Chinese jugglers with this snake in their stock in trade, and I believe that it is this species that is even now occasionally met with in houses in the heart of the town of Shanghai. On October 3rd, 1901, I captured a young one recently hatched in camp which closely resembled the adult in colouring. Loreal: in one specimen there are two superposed shields on one side. Temporals: a single anterior in one specimen on one side. Anterior chin-shields in contact with four lower labials on both sides in one specimen. Ventrals 190–199. Subcaudals 96–119.

33. Zamenis korros. Sikkim Himalayas, Assam, Burma, Siam, Malay Peninsula, Sumatra, Java, W. Yunnan, S. China, Hainan, Hongkong, Formosa (*City Hall Mus.*).—I obtained one specimen on the mainland opposite Hongkong. There are two specimens in the Siccawei Museum. Loreal single on both sides in one specimen, three on one side in one specimen. Subcaudals 100–116.

34. Zamenis mucosus. Southern Asia from Transcaspia to Malay Peninsula, Java, S. China, Hainan (*City Hall Mus. & Herz*), Hongkong, Formosa, Chusan (*Cantor & Günther*).—I obtained two examples from Stonecutter's Island in Hongkong Harbour, and three from the mainland opposite Hongkong. There are two specimens in the Siccawei Museum. Labials nine, the fifth and sixth touching the eye in one specimen on one side.

35. ZAMENIS SPINALIS. Siam, Hainan, China, Corea, Mongolia. This snake is evidently very common in the Yangtse Valley, as there are ten specimens in the Siccawei Museum. Concerning one which I obtained from Huangtsun, N. China, my donor wrote me that he had found it in his verandah, it having dropped, he believed, from the roof about 7 feet above. He discovered it in the act of devouring a lizard (*Gecko subpalmatus*). It had seized the gecko by the body and was encircling it in its coils. A little later, when the captive had exhausted its futile struggles, the snake seized it by the snout and began to swallow it. Frontal three-fourths to four-fifths parietals. Loreals: two (anterior and posterior) on both sides in one specimen. Subocular absent in one specimen on one side. Præoculars: the upper touches the frontal in two specimens on both sides. Temporals: two anterior in all specimens. Labials: eight, with the fourth and fifth touching the eye in two specimens only, the normal arrangement being nine, with the fifth and sixth touching the eye. Anterior chin-shields in contact with four lower labials in two specimens on both sides. Ventrals 179–207. Subcaudals 84–100.

36. COLUBER PORPHYRACEUS. E. Himalayas, Hills in Assam, Burma, Malay Peninsula, Sumatra, Yunnan (*Anderson*).

37. COLUBER MANDARINUS. Chusan, China (N.W. Fokien, *Blgr.*; Prov. Chihli, *Möll.*). I saw one specimen in the Siccawei Collection. It is called by the Chinese "'Hua-tai-tsze," meaning variegated girdle (*Möll.*).

38. COLUBER RUFODORSATUS. E. Siberia, China, Chusan, Formosa, Hainan.—Evidently a very common snake. There are five in the Shanghai Museum, and a large number at Siccawei. Frontal often greater than distance to end of snout. Anterior chin-shields in contact with four infralabials in one specimen out of fifteen examined.

39. COLUBER DIONE. S. Russia, Transcaucasia, Temperate Asia, China, Hainan, Japan (*Blgr.*).—Evidently a very common snake in the Yangtse Valley, as the Siccawei Collection contains a large number of specimens. I obtained two from an officer in Ching-wang-tao, N. China, who told me the snake was common there. One specimen contained the brood of some small bird, four in number, one of which was still partly enveloped in its shell. Frontal often greater than its distance to end of snout, sometimes equalling parietals. Præoculars: three on one side in one specimen. Postoculars: one on both sides in one specimen out of sixteen examined. Labials nine, with fourth and fifth touching the eye on one side in one specimen; nine with fifth and sixth touching the eye on one side in two specimens only. Anterior chin-shield often greater than posterior, in contact with six infralabials on both sides in one specimen, and on one side in one specimen. Scales in mid-body 23 in three specimens, 25 in ten,

and 27 in one specimen. This species is called "Huang-ch'ang-ch'ing" by the Chinese (*Möll.*).

40. Coluber tæniurus. Sikkim, Cochin China, Siam, Malay Peninsula, Borneo, Sumatra, China, Formosa (*Senckenberg Mus.*, *Boettg.*), Chusan, Manchuria.—This snake is common in the Yangtse Valley. I encountered one near Shanghai, which, however, I failed to capture as it took to water and disappeared in the submerged vegetation. Loreals confluent with præfrontals on both sides in one specimen. Temporals: single on both sides in one specimen, and on one side in one specimen. Labials: nine with the fourth and fifth touching the eye in one specimen on both sides. Ventrals 226–242.

41. Coluber schrenckii. Amoorland, Corea, N. Japan.

42. Coluber phyllophis. China.—I saw seven specimens in the Siccawei Museum, the largest measuring 8 feet 1 inch. There is also a stuffed specimen in the Shanghai Museum. Scales 21 in mid-body in one specimen. Ventrals 221 in one specimen.

43. Coluber davidi. China (*Sauvage*).

44. Coluber mœllendorffii. China (*Herz & Broeckelmann*).

45. Coluber melanurus. Burma, Malay Peninsula, Borneo, Sumatra, Java, S. China.—I saw one specimen in the City Hall Museum from Java. Subcaudals 88.

46. Coluber radiatus. E. Himalayas, Bengal, Assam, Burma, Cochin China, Malay Peninsula, Sumatra, Java, S. China (*Müll.*, *Herz*, *Möll.*, *Kaufm.*, *Broeckl.*), Hongkong (*City Hall Mus.*).—There are five specimens in the City Hall Museum from Hongkong. I also obtained one specimen from that island which contained four blind and callow offspring, the brood of some small mammal, probably a rat [1].

47. Dendrophis pictus. S. Asia from India to Malay Archipelago, China (*Günth.*), Hongkong, Philippines.—One specimen of this snake in spirit was given me by a lady, who assured me she had obtained it on Hongkong Island.

48. Simotes purpurascens. Siam, Cochin China, Malay Peninsula, Sumatra, Borneo, Java, S. China [2].

49. Simotes cyclurus. Bengal, Assam, Burma, Siam, Cochin China, Malay Peninsula, Sumatra, S. China.

50. Simotes formosanus. S. China, Formosa.

51. Simotes violaceus. Bengal, Assam, Burma, Camboja,

[1] *Coluber climacophorus* vel *Elaphis virgatus*, described by Boettger (Mat. herp. Faun. von China, 1888, p. 72) from Corea, is, I think, an error. The specimen alluded to is evidently *Coluber schrenckii*.

[2] Duméril & Bibron, 'Erpétologie,' p. 632.

S. China, Hainan, Hongkong.—I saw one specimen in the City Hall Museum, and obtained two myself on the mainland opposite Hongkong. One was caught in grass on the hillside and suffered itself to be handled without retaliation. The other was caught on a shrub poised over a flower. Frontal: length greater than distance to end of snout in three specimens. Labials: six with the third and fourth touching the eye on one side, seven with the fourth and fifth touching the eye on the other side in one specimen. Nasals semidivided on both sides in one specimen.

52. Simotes chinensis. China, Hainan.—Rostral: visible portion seen from above equals distance to frontal in two specimens. Labials seven, with the fourth only touching the eye on both sides in one specimen. Subcaudals 50 in one and 51 in another specimen. I saw two specimens in the Siccawei Museum, and obtained one myself from Kiangyin on the southern bank of the Yangtse River, to the north-west of Shanghai.

53. Simotes vaillanti. China (*Sauvage*).

54. Ablabes major. China, Hongkong (*Günth., Hallow., City Hall Mus.*), Formosa, Chusan Archipelago.—Evidently fairly common in the Yangtse Valley. I saw one specimen of this snake, belonging to Mr. Styan, in Shanghai, and many others in the Siccawei Collection. There are three in the City Hall Museum, two of which are from Formosa, the other of uncertain habitat. I saw one specimen in Mr. Armstrong's collection in Hongkong obtained from that island, where, as he told me, it is not uncommon. Labials: in one specimen seven, with the third and fourth touching the eye on one side. Subcaudals 89 in one specimen, and 90 in two others.

55. Ablabes doriæ. Kachin Hills, Assam, China.—I saw one small specimen 8 or 9 inches long in the Siccawei Collection. Ventrals 160? Subcaudals 85? It agrees in every particular with Mr. Boulenger's description. This species has not been previously recorded from China.

56. Calamaria pavimentata. Burma, Siam, Cochin China, Malay Peninsula, Java, S. China (*Möll.*), Riu Kiu Archipelago (*Stejneger*[1]).

57. Calamaria berezowski. S. China (*Günth.*[2]).

58. Calamaria septentrionalis. China, Chusan Archipelago, Hongkong.—I saw two specimens in the Siccawei Collection, both quite typical.

59. Spaniopholis souliei. Yunnan (*de Scabra*[3]).

[1] Stejneger (Proc. Biol. Soc. Wash. xiv. p. 191) describes a snake as new to science under the name of *Calamaria pfefferi*, which, in my opinion, is a specimen of *C. pavimentata*.

[2] Ann. Ac. St. Pétersb. 1896, p. 205, pl. i. fig. A.

[3] Bull. Mus. N. H. Paris, iii. 1897, p. 216.

60. Hypsirhina plumbea. Burma, Indo-China, Malay Peninsula and Archipelago, S. China, Hainan, Hongkong, Formosa.—I saw two specimens in the City Hall Museum, one labelled China and one Hongkong, and I obtained four myself on the mainland opposite Hongkong. All my specimens were caught in or about a sluggish stream near our camp at Kowloon. Frontal: length greater than distance to end of snout in six specimens. Anterior chin-shields in contact with six infralabials in two specimens on one side. I noticed that in some specimens the lateral scales about the anal region had minute central tubercles, reminding one of the condition in *Aspidura copii* and *A. trachyprocta*.

61. Hypsirhina enhydris. India, Ceylon, Burma, Siam, Cochin China, Malay Peninsula, Borneo, Celebes, S. China, Hongkong.

62. Hypsirhina bennetti. China, Hainan (*Herz*).

63. Hypsirhina chinensis. Siam, China, Hainan, Hongkong (*Steindachner*[1]).

64. Homalopsis buccata. Bengal?, Burma, Indo-China, Malay Peninsula, Sumatra, Borneo, Java, Hongkong (*Hallow. & City Hall Mus.*).—I examined the specimen in the City Hall Museum which is labelled Hongkong.

65. Dipsadomorphus kraepelini: *Boiga kraepelini* Stejneger (Proc. Biol. Soc. Wash. 1901, xv. p. 15). Formosa.—I found one old specimen in the City Hall Museum labelled Formosa. This specimen almost exactly accords with Stejneger's description, the only points of difference being:—Temporals are six on one side. Labials ten on one side. Anterior chin-shields in contact with five lower labials on both sides. Ventrals 244. Subcaudals 140.

66. Dipsadomorphus multimaculatus. Burma, Indo-China, Malay Peninsula, Sumatra, Java, Celebes, S. China, Hongkong.—A common snake in the south of China. I obtained six from Hongkong Island, one from Stonecutter's Island in that harbour, and one from the mainland opposite Hongkong. There are several specimens in the City Hall Museum, and I saw others in spirit and in captivity belonging to Mr. Armstrong.

67. Psammodynastes pulverulentus. E. Himalayas, Khasi and Assam Hills, Burma, Indo-China, Malay Peninsula and Archipelago, Formosa.

68. Chrysopelea ornata. Ceylon, Hills of S. India, Bengal, Assam, Burma, Indo-China, Malay Peninsula and Archipelago, S. China, Hongkong?[2]—I found one specimen in the Siccawei

[1] Reise der Novara, Rept., Wien, 1869, p. 68.

[2] The specimen referred to by Boettger (Mat. herp. Fauna von China, p. 142) is no longer in the City Hall Museum.

Museum and one in the Shanghai Museum. Subcaudals 144 in one specimen.

69. Aipysurus annulatus. Loyalty Islands, Loo Choos, Seas around Formosa (*Stejneger*)[1].

70. Hydrus platurus. Obok, Red Sea, Indian Ocean, Straits of Malacca, Tropical and Subtropical Pacific from Loo Choo to Australia and New Zealand, Malay Archipelago to Central America.—I saw two specimens in the City Hall Museum from Hongkong and Formosa, and one in the Shanghai Museum. Also two or three specimens in Mr. Owston's collection in Yokohama, obtained from the Japanese shores or the Loo Choos. All belong to variety E of the British Museum Catalogue of Snakes. Frontal: length less than distance to end of snout in one specimen, less than parietals in two. Labials nine on one side in two specimens; none bordering the eye on one side in two specimens. Anal tetrafid.

71. Acalyptophis peronii. Western Tropical Pacific.

72. Hydrophis fasciatus. Coasts of India to China and New Guinea.

73. Hydrophis gracilis. Coasts from Persia to China. Hainan (*Herz*).

74. Hydrophis melanocephalus. Indian Ocean, Pescadores, (*Stejneger*)[2], Loo Choos.

75. Hydrophis obscurus. Bay of Bengal to China. Canton (*Peters*)[3].

76. Distira stokesii. Mekran Coast to Chinese Sea and North Coast of Australia.

77. Distira ornata. Coasts of Asia from mouth of Persian Gulf to Loo Choos, New Guinea, and N. Australia.—This snake evidently is common in the Loo Choos, as I saw more than twenty specimens from that region in Mr. Owston's collection.

78. Distira subcincta. Indian Ocean, Japan, Loo Choos (*Stejneger*)[4].

[1] Stejneger (Journ. Sc. Coll. Tokyo, xii. 1898–1900, p. 223) describes as a new species under the name of *Emydocephalus ijimæ* certain specimens, the description of which I have consulted Mr. Boulenger about; and he is of opinion that these will be found to be specimens of *Aipysurus annulatus*. The enlarged vertebrals and presence of four præfrontals, found in these specimens, were also present in some specimens I examined belonging to Mr. Owston in Yokohama, which I regarded at the time as *annulatus*. An examination of the specimens in the British Museum shows that a certain slight enlargement of the vertebrals is present at some spots, but no specimen has four præfrontals. The weight of such an opinion compels me to modify the views I had formed on the subject.

[2] J. Coll. Japan, xii. p. 224 (*Microcephalophis melanocephalus*).

[3] Monatsb. Berlin. Akad. 1872, p. 859 (*H. diadema*).

[4] Stejneger (Proc. Biol. Soc. Wash. xiv. p. 191, 1901) describes certain specimens obtained from the Riu Kiu Seas as *Distira orientalis*, which he considers a new species. From his description I am of opinion that these belong to *D. subcincta*.

79. Distira brugmansii. Persian Gulf to Chinese Sea. Hainan (*Boettg.*)[1].

80. Distira cyanocincta. Persian Gulf to Chinese Seas, Japan, Papuasia.—I saw one specimen of this snake in the City Hall Museum labelled *Hydrus major* from Hongkong, and one in the Shanghai Museum. One conforms to type A, and the other to type C of the British Museum Catalogue.

81. Distira viperina. Persian Gulf to Chinese Sea.

82. Enhydris hardwickii. Bay of Bengal to Chinese Sea and Coast of New Guinea.—There are four specimens in the City Hall Museum: two, labelled *Hydrus major*, are from Manila, and two from Bangkok. There is one specimen in the Shanghai Museum with very markedly spinose tubercles on the median six ventral rows of scales. These rows are also enlarged. Labials eight in two specimens, in one on both sides and in the other on one side only.

83. Platurus laticaudatus[2]. Bay of Bengal to Chinese Sea, Loo Choos, New Guinea, and Western South Pacific Ocean. There are three specimens in the City Hall Museum labelled Formosa, and I saw several specimens in Mr. Owston's collection obtained from the Loo Choo Islands. Ventrals 232–246. Subcaudals 32–46.

84. Platurus colubrinus. Bay of Bengal to Chinese Sea, Western South Pacific Ocean.—I examined two specimens, both in the City Hall Museum, one from Penang and the other of uncertain habitat.

85. Bungarus fasciatus. Southern Asia from Bengal to China, Hongkong (*City Hall Mus.*).—I obtained one specimen from the mainland opposite Hongkong, and I saw two others in the City Hall Museum, one from Hongkong and the other from the mainland opposite.

86. Bungarus candidus. Southern Asia from India to China, Hainan, Hongkong (*City Hall Mus.*), Formosa.—I saw two specimens in the Shanghai Museum, one in the Siccawei Collection, and one in the possession of Mr. Styan in Shanghai. There are four specimens in the City Hall Museum, one from Hainan and three from Hongkong. All these specimens are of variety B of the British Museum Catalogue, viz. *multicincta*. Postoculars: the normal lower shield confluent with the fourth labial on both sides in one specimen. Labials six, with the second and third

[1] Under the name of *Hydrophis cyanocinctus* Boettger (Mat. herp. Faun. von China, 1888, p. 88) describes three specimens of what I consider *Distira brugmansii*, collected by Herz in Hainan.

[2] The species described by Boulenger (Cat. Snakes Brit. Mus. iii. p. 309) as *Platurus muelleri* I do not believe to be valid, and I think the specimens on which it is based will prove to be *P. laticaudatus*. The only definite point he mentions to characterize it is the presence of a median ventral keel in the posterior half of the body, and I have found this peculiarity in at least three specimens of what I consider undoubted *P. laticaudatus*.

touching the eye on one side in one specimen, and occasioned by a confluence between the first and second labials. Anterior chin-shields in contact with four infralabials on both sides in three out of four specimens examined.

87. Naia tripudians. Southern Asia from Transcaspia to China, Hainan, Hongkong (*Hallow., Steindach., City Hall Mus.*), Formosa, Chusan, Philippines.—In the Siccawei Museum I saw seven specimens, and in the Shanghai Museum three. There are fifteen in the City Hall Museum, of which eleven are from Hongkong, two from Hainan, and two from China. Of the ten specimens I examined three have scales in twenty-one rows in the middle of the body, and three in nineteen. In the remainder I have failed to record the number. Nine have more or less distinct (some very well defined) buff or pale yellowish cross-bands dorsally. These numbered from 13–21 on the body, and 5–8 on the tail. They involve one or two rows of scales along the length of the snake, and are most conspicuous in the posterior third or so of the body. The intervals involve from ten to twelve scales, and are sometimes separated from cross-bars by a blackish line. Hood marked with modified black ocellus. Belly yellow, with one or two plumbeous bands ventrally, or mottled to a variable extent with black. In one specimen the whole belly uniform black. One specimen is evidently a Sputatrix. This I found in the Siccawei Collection. Scales over hood 21, mid-body 17. Ventrals 177. Subcaudals 45. No hood-marks. Nearly uniform black dorsally, with no suspicion of cross-bars. One very broad plumbeous ventral band involves from the 9th to the 47th shield, and then breaks up into a mottling and disappears.

88. Naia bungarus. Southern Asia from India to S. China, Hongkong (*City Hall Mus.*), Philippines.—A newly-hatched example is preserved in the City Hall Museum, habitat Hongkong. I found the head of a large specimen in the Shanghai Museum; and whilst I was in Hongkong a gentleman encountered one on the mainland opposite, which he killed and brought home. I examined and identified it, and estimated it at between seven and eight feet in length.

89. Callophis macclellandii. Nepal, Sikkim, Assam, Burma, S. China, Formosa.

Amblycephalidæ.

90. Amblycephalus moellendorffii. Tenasserim, Siam, Cochin China, S. China, Hongkong, Hainan.—This is a common snake in the island of Hongkong. I collected ten myself, all of which were found in low jungle on the slopes of the Peak. I saw three specimens in the City Hall Museum. Internasals form a suture with the loreal in all specimens. Postoculars and suboculars: usually one long semilunar shield extends from the supraoculars behind, skirting the eye to a point about halfway up its anterior aspect. Sometimes this scale is divided so as to form a small

postocular above this shield. Temporals: the antero-superior extends back as far as the extreme border of the parietals or further. Labials: six in two specimens on both sides. Subcaudals 36–50. First infralabials meet in four, fail to meet in one, not recorded in eight.

91. Pseudopareas vagus. Hongkong (*Jan*).

Viperidæ.

92. Ancistrodon acutus. China.—Called by the Chinese "Oo-woo-shay," or five-pace snake, owing to the reputed rapidly fatal effects of its bite. I saw one specimen in the City Hall Museum labelled *A. blomhoffii*, habitat Szechuen. There are also five specimens in the Siccawei Collection. Two are labelled Ou-Yuen[1], and one of these dated 1882 (*i. e.* six years before Günther first described it). One is labelled Chowtong[2] 1883, and another Kien-té[3] 1882. The fifth consists of a dried skin. In talking to the late Père Heude about this creature, he told me it is not uncommon in hilly parts of the Yangtse Valley, and is feared by the natives more than a leopard. He narrated an experience of one of the Jesuit Fathers who heard frantic cries for help issuing from some dense jungle he was riding through. On dismounting, and proceeding to the spot, he found a Chinaman being pursued by one of the snakes, which he attacked and killed. Rostral: as far as I could ascertain there is only one shield beneath the dermal appendage, which, however, is frequently bent over, causing a furrow which makes the shield appear divided into two. Labials: six in one specimen on both sides, and in another on one side. Subcaudals 56 in one specimen, with 1st–11th entire and rest divided; 53 in another, with 1st–9th entire and rest divided; 58 in another, with 1st–28th entire and rest divided; 57 in another, with 1st–12th entire and rest divided.

93. Ancistrodon blomhoffii. E. Siberia, Mongolia, China, Hainan, Formosa, Japan, Loo Choos, Siam.—Möllendorff says it is called by the Chinese "Fei-shang-ts'ao," snake which flits on the grass, and "Ch'i-ts'un-tsze," or seven-inch snake. It is very common in the Yangtse Valley. There are at least three specimens in the City Hall Museum from Japan. There are five in the Shanghai Museum, and a very large number in the Siccawei Collection. In Mr. Owston's collection I saw several obtained from Japan and the Loo Choos. I obtained five myself about Shanghai in our camp. Two of these, which I found close together on October 16th, 1901, appeared to be newly hatched. On the 4th October, 1901, my servant informed me that there were several snakes lying together dead close to the camp. I investigated the matter, and found an adult of this species with the remains of

[1] Perhaps Tao-yuan in Province Hunan?
[2] Perhaps Chao-tung in North Yunnan?
[3] In Province An-Hui.

twelve young scattered around her. In spite of every endeavour, I failed to trace the author of this butchery. It is sad luck that such opportunities as these for observing habits rarely fall to the lot of those who specially seek them. Residents about Shanghai occasionally lose dogs under circumstances suggesting a poisonous bite, and I think these fatalities are frequently due to this little snake. One specimen I captured had the penis bifid on both sides. I kept young on two or three occasions, but could not find suitable food with which to tempt them, and finally resorted to feeding them with boluses of raw meat, a treatment they displayed their distaste for by repeatedly disgorging the morsels some time later. I observed that, when molested and excited, all my specimens vibrated the tail, but I could never get one actually to strike; however all the specimens I had alive were very small. Labials seven, the third only touching the eye; eight in one specimen on both sides.

94. Lachesis jerdonii. Khasi Hills, Assam, Thibet; Upper Yangtse, China.

95. Lachesis mucrosquamatus. Naga Hills, Assam; Formosa.

96. Lachesis gramineus. South-eastern Asia, China, Hainan (*Herz & City Hall Mus.*), Hongkong, Formosa.—This is a very common snake in Hongkong, where I procured three specimens. There are also twelve in the City Hall Museum, obtained locally. In one of these the skin of the neck had been perforated and rent by the beak of a bird which it is seen in the act of devouring. The distension of the mouth and neck is enormous, so that the bird appears as if it were being thrust through the rent instead of into the gullet. There is only one specimen in the Shanghai Museum, and only one in the Siccawei Collection. The residents of Hongkong call this the Bamboo-snake, which is a very good name for it since it is almost always to be found in the foliage of bamboo vegetation. I am told too that the Anglo-Indians in Assam have also given this name to the snake.

Part II.—List of Japanese and Loo Choo Islands Ophidia.

Colubridæ.

1. Tropidonotus vibakari. Japan, Formosa, Manchuria.—I found one in the City Hall Museum from Nagasaki, and saw six others in Mr. Owston's collection, all from Mount Fuji. Ventrals 152 in one specimen. Subcaudals 80 in one specimen; second to fifth entire in one specimen.

2. Tropidonotus tigrinus. Siam, Cochin China, China, Hainan, Hongkong ?, Manchuria.—In my opinion this is the commonest snake in Japan. I frequently met with it, and on one occasion captured five in a couple of hours. It is called by the Japanese "yamakagashi," "uwabami," "orochi," "ja," all of which terms, I

am informed, signify "the largest variety"; also "tora-no-kuchinawa," or "tiger-snake"; also "miza kuchinawa," or "water-snake"; also "atsuki kuchinawa," or "thick brown snake." (See also No. 12 of Chinese list.)

3. Tropidonotus pryeri. Loo Choos.—I saw one specimen in Mr. Owston's collection from Nawa in the Loo Choos.

4. Achalinus spinalis. China, Japan. (See No. 26 of Chinese list.)

5. Dinodon rufozonatus. China, Hainan, Formosa, Chusan, Corea, Tsu Shima, Japan, Loo Choos. (See No. 30 of Chinese list.)

6. Dinodon semicarinatus. Loo Choos.

7. Dinodon japonicus. Japan.—I found one specimen on the Southern Island (Kiu Siu), and saw another in Mr. Owston's collection. Ventrals 209. Subcaudals 75? and 77.

8. Dinodon tessellatus. Japan.

9. Coluber dione. S. Russia, Transcaucasia, Temperate Asia, China, Hainan, Japan (*Blgr.*). (See No. 39 of Chinese list.)

10. Coluber schrenckii. Amoorland, Corea, N. Japan.

11. Coluber conspicillatus. Japan, Corea.—I saw one specimen in the City Hall Museum labelled Nagasaki and another in Mr. Armstrong's collection captured in Japan. Called by Japanese "jimuguri" ("earth borer") and "kawara kuchinawa" ("dry-river-bed snake").

12. Coluber climacophorus. Japan.—A very common snake in Japan, where it is called "aodaisho," "nezumi tori" (or "rat-catcher"), "sato meguri" (or "village idler"), and "mugiwara hebi." I frequently encountered it. I saw and captured one reclining on a stone parapet in one of the Nikko temples. I discovered another in thick jungle in the act of swallowing a half-grown leveret, truly an enormous meal, since the mammal was more than twice the weight and girth of the reptile. I thought on all occasions it was far less wary and active than other nearly allied snakes of a similar size with which I am familiar, such, for instance, as *Zamenis mucosus* and *Z. korros*, *Coluber radiatus*, *Zaocys dhumnades*, &c. Temporals, in one specimen, three on both sides.

13. Coluber quadrivirgatus. Japan, Corea.—This species is almost if not quite as common in Japan as *Tropidonotus tigrinus*. I scarcely went a day in the country without seeing one, and often I saw three or four. It is called by the Japanese "shima hebi" (or "striped variety"), "karasu hebi" (or "black snake"), "sukuro hebi" (or "medium black snake"), "mugiwara hebi" (or "wheat straw snake"), and "kuro kuchinawa." Subocular absent in one specimen on one side. Labials eight, with third, fourth, and fifth touching the eye on one side in one specimen.

14. Coluber schmackeri. Loo Choos.

15. Ablabes semicarinatus. Japan, Loo Choos.

16. Ablabes herminæ. Loo Choos.—I saw two specimens in Mr. Owston's collection from the Loo Choos. Ventrals 162–163. Subcaudals 47–51.

17. Calamaria pavimentata. Burma, Siam, Cochin China, Malay Peninsula, Java, S. China (*Möll.*), Riu Kiu Archipelago (*Stejneger*). (See No. 56 of Chinese list and footnote.)

18. Hydrus platurus. Coasts of Asia from Red Sea to Loo Choos, Australia, New Zealand, Malay Archipelago to Central America.—Called "umi hebi" or "sea snake" by Japanese. (See No. 70 in Chinese list.)

19. Hydrophis melanocephalus. Indian Ocean, Pescadores (*Stejneger*), Loo Choos.—This is evidently a common snake about the Loo Choos, since I saw upwards of twenty specimens in Mr. Owston's collection from this locality. Postoculars one or two. Temporals: one anterior usually, sometimes two. Scales two head-lengths from snout 23–27, mid-body 31–35. Ventrals 305–343. Anal tetrafid. (See No. 74 of Chinese list.)

20. Distira cyanocincta. Persian Gulf to Chinese Seas, Japan, Papuasia. (See No. 80 of Chinese list.)

21. Distira ornata. Coasts of Asia from mouth of Persian Gulf to Loo Choos, New Guinea, Northern Australia. (See No. 77 of Chinese list.)

22. Distira subcincta. Indian Ocean, Japan, Loo Choos (*Stejneger*). (See No. 78 of Chinese list and footnote.)

23. Aipysurus annulatus. Loyalty Islands, Loo Choos, Seas around Formosa (*Stejneger*). (See No. 67 of Chinese list and footnote.)

24. Platurus laticaudatus. Bay of Bengal to Chinese Sea, Loo Choos, New Guinea, Western South Pacific Ocean. (See No. 83 of Chinese list.)

25. Platurus colubrinus. Bay of Bengal to Chinese Sea, Western South Pacific Ocean. (See No. 84 of Chinese list.)

26. Platurus schistorhynchus. Western Pacific Ocean, Loo Choos.

27. Hemibungarus japonicus. Loo Choos, Japan?

Viperidæ.

28. Ancistrodon intermedius. Japan, Mongolia, Eastern Siberia, Central Asia.

29. Ancistrodon blomhoffii. Eastern Siberia, Mongolia, China, Hainan, Formosa, Japan, Loo Choos, Siam.—Called by the Japanese "mamushi," "hami," "kuchibami," "hiraguchi." All synonymous terms for the "beautifully marked variety."

30. Lachesis okinavensis. Loo Choos.—Called by the Japanese "habu."

31. Lachesis flavoviridis. Loo Choos.—Also called "habu" by the Japanese.

32. Lachesis mucrosquamatus. Naga Hills, Assam; Formosa.

33. Lachesis luteus. Loo Choos.

3. Note on the Wild Sheep of the Kopet-Dagh.

By R. Lydekker.

[Received December 4, 1902.]

(Text-figure 10.)

Through the generosity of Mr. St. George Littledale the collection of the British Museum has recently been enriched by a very fine skull, with the horns (text-fig. 10, p. 103), of a ram of the Wild Sheep of the Kopet-Dagh range, which forms the boundary between Turkestan and Northern Persia to the eastward of the Caucasus. Mr. Littledale also brought home the skin of the same animal, but it unfortunately was so badly injured by vermin that it had to be destroyed. The skull is the finest of the series obtained during the trip.

The Kopet-Dagh sheep was named *Ovis arkal* in 1857 by Blasius, and is evidently allied to the Urial, with the Punjab race of which I have indeed proposed to identify it[1]. At that time I had, however, never seen an adult skull; and Mr. Littledale's specimen indicates the right of this sheep to rank as a distinct race of Urial. It will be remembered that the Punjab race of the Urial (*O. vignei cycloceros*), as exemplified at any rate by specimens from Peshawer and Afghanistan in the British Museum, differs from the typical *O. vignei* of Astor and Ladak by the much greater prominence of the two front angles of the horns, which are often raised into nodose beads, between which the front surface of the horn is depressed and carries bold and widely separated transverse ridges.

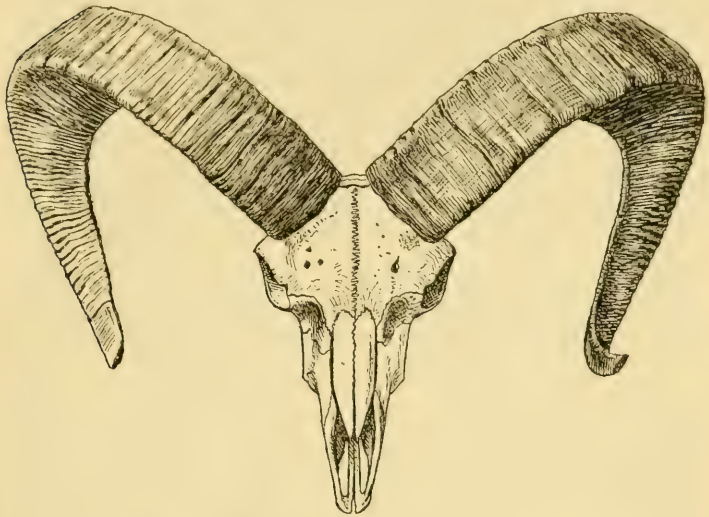
In the Kopet-Dagh Urial this prominence of the front angles of the horns is still more pronounced, though the beading is somewhat less conspicuous. Moreover, the front surface of the horn is unusually broad and flattened, with the transverse

[1] 'Wild Oxen, Sheep, and Goats,' p. 173.

wrinkles very low and indistinct. The length of the horn is 33 inches along the inner front angle, with a basal circumference of 11 inches, a basal width of 3 inches, and a basal depth of 4 inches.

The last two dimensions are considerably greater than in a skull of the Kelat Urial measured by Mr. Hume, in which the length along the curve is $35\frac{3}{4}$ inches.

Text-fig. 10.



Front view of skull and horns of adult ram of the Kopet-Dagh Urial. $\frac{1}{4}$ nat. size.

The Kopet Dagh Urial decidedly appears to be a distinct form, connected with the typical *Ovis vignei* by means of the Punjab race of that species. On these grounds I regard it as a local race rather than a species; its name will accordingly be *O. vignei arkal* (or perhaps *arcal*). The suggestion of M. Dauvergne [1], that this sheep is identical with the Kelat Urial, is not borne out by a comparison of the present specimen with a skull of that form in the British Museum, in which the angles of the horns are much rounded off. This leads me to think that the Kelat Urial (*O. vignei blanfordi*) is, after all, distinct from the Punjab animal.

[1] See p. 131 of my book on 'Game of Europe, N.W. Asia, and America.'

4. On new Parasitic Copepoda from Zanzibar and East Africa, collected by Mr. Cyril Crossland, B.A., B.Sc. By Staff-Surgeon P. W. Bassett-Smith, R.N., F.Z.S.

[Received December 4, 1902.]

(Text-figures 11 & 12.)

Mr. Cyril Crossland, in his recent examination of the marine fauna of Zanzibar and British East Africa, obtained several specimens of parasitic and semiparasitic Copepods, three of which he has been kind enough to allow me to examine.

These curiously deformed and often grotesquely-shaped animals are frequently found attached to the gills, &c., or to the surface of fish and other marine animals.

A large number from the former which are now described from a variety of different hosts, and from wide geographical areas, I enumerated in Proc. Zool. Soc. 1899, p. 438; to this paper I have appended a list of addenda, which I have drawn up with the kind assistance of Mr. E. Bergrotti, of Tammerfers, and others.

Not only fish but a number of other marine animals are undoubtedly infested with these parasites, though at present little information concerning them has been collected; the specimens of Mr. Crossland are therefore particularly interesting.

Gerstäcker, in Bronn's 'Klass. und Ordn. des Thier-Reichs,' 1866–79, Crustacea, vol. v. Copepoda, p. 774, mentions five genera found on Nudibranch Mollusca: *Doridicola* Lyd., *Eolidicola* Sars, belonging to the family Ergasilidæ; *Artotrogus* Boeck, to the family Ascomyzontidæ; and *Splanchnotropus* Hanc. and *Ismailia* Bergh, to the family Chrondracanthidæ. Also nine genera from various Vermes, p. 773.

Of the three specimens of Mr. Crossland, two were taken from the kidneys of species of Pleurobranchids (not determined) and one from the skin of a Sipunculid (*Aspidosiphon*).

As they were only single specimens it was impossible to dissect them, and therefore the descriptions are necessarily incomplete. The first two evidently belong to the family Chondracanthidæ, but do not fall in with the descriptions of any known genus; they appear to be most nearly related to the genus *Splanchnotropus* of Hancock (Trans. Linn. Soc. vol. xxiv. pp. 51, 55), two species of which he describes, *S. gracilis* and *S. brevipes*, taken from Nudibranchs; the present specimens differ from them, however, in the complete absence of antennæ and articulate limbs, and in having the external ovaries elongated and the eggs arranged in single series.

I have therefore provisionally placed them in a new genus, *Chondrocarpus*, following closely after *Splanchnotropus* Hanc. and *Diocus* Fabr.

Chondrocarpus, gen. nov.

♀. Cephalothorax coriaceous, elongated, with four lateral short

lobe-like processes on either side; abdomen one-fourth length of whole, biarticulate, tapering; no distinct antennæ or thoracic limbs; mouth placed on under surface, with minute maxillæ; external ovaries as elongated filiform sacs containing ova in a single series.

♂. Pigmy.

Chondrocarpus reticulosus, sp. n. (Text-fig. 11, A–G.)

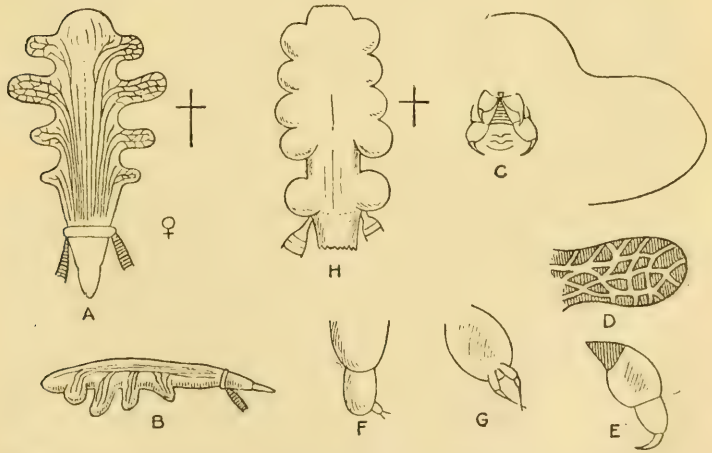
Hab. Zanzibar: from large Pleurobranchid.

Length 12 mm., breadth 4 mm.

♀. Cephalothorax indistinctly segmented, elongated, tapering, dorsally convex, laterally produced into 4 rounded truncated processes; the 4th pair being most widely separated and the smallest; the whole having a peculiar reticulate appearance from the network of ramifying tubules; anterior extremity rounded; no visible antennæ; mouth as a papilla placed between the 1st pair of processes; upper lip triangular; only one pair of maxillæ and mandibles (?) could be made out, each terminating in minute claws. No thoracic limbs; there is a short genital segment, or ring, from which spring the long filiform ovaries. Abdomen indistinctly biarticulate, tapering, without caudal plates or setæ.

♂. Pigmy. One was seen attached to the last abdominal segment but was partially hidden, the bifid articulate caudal extremity only being visible.

Text-fig. 11.



Chondrocarpus reticulosus ♀, gen. & sp. n. A. Dorsal surface. B. Lateral view. C. First segment and mouth-organs. D. One of the lobes showing reticulate appearance. E. Second maxilliped. F. Abdomen showing fixed ♂. G. Posterior extremity of ♂. H. *Chondrocarpus* sp. ♀: dorsal surface (specimen incomplete).

Chondrocarpus sp. (Text-fig. 11, H.)

A specimen of a second species of this genus was taken from a

Pleurobranchid; it was much broken both at the anterior and posterior extremities. It differs from *C. reticulosus* in not having the peculiar reticulate appearance and in having a pair of lateral lobes on either side of the genital segment.

The third specimen also appears to be new, and belongs to the family Dichelesthiidæ, the animal resembling most nearly the genus *Enterocola* of Van Beneden (Bull. Acad. Roy. de Belg. tom. ix. 2nd ser. p. 151), found by him in the respiratory cavity of "*Aphidium ficus*," than any other form I have been able to find recorded.

Mr. Crossland's specimen appears to be much more degenerate from its parasitic habits; the articulate limbs are excessively small, difficult to make out, and the ova are carried in long spiral thread-like processes in a single series as in the Caligidæ, and not in dilated sacs. Unfortunately there was only this single female specimen for examination. I would provisionally create for it a new genus "*Ventriculina*," giving the specific name of "*crosslandi*" in recognition of the collector.

Ventriculina, gen. nov.

Head small, rounded; neck indistinct; 3 thoracic segments, the first amalgamated with the head; genital segments lobed, equal in breadth with the thoracic; no dorsal plates; abdomen short, biarticulate; external ovaries spiral, ova uniserial; first antennæ 4-jointed, simple, second antennæ 3-jointed; maxillipeds very small.

Three pairs of minute thoracic limbs, first biramose, second and third uniramose.

Ventriculina crosslandi, sp. n. (Text-fig. 12, p. 107.)

Hab. Zanzibar: from a Sipunculid.

Total length 4 mm. Colour white.

Head small, rounded in front, broadest behind, from under which project the anterior antennæ. Thoracic segments three, the first united with the head, the genital segments trilobed; the whole forming an oblong body without lamellar plates, showing five distinct rounded lateral lobes, the last pair being slightly wider and more acute. Dorsal surface convex, marked by five distinct grooves showing the position of the union of the segments.

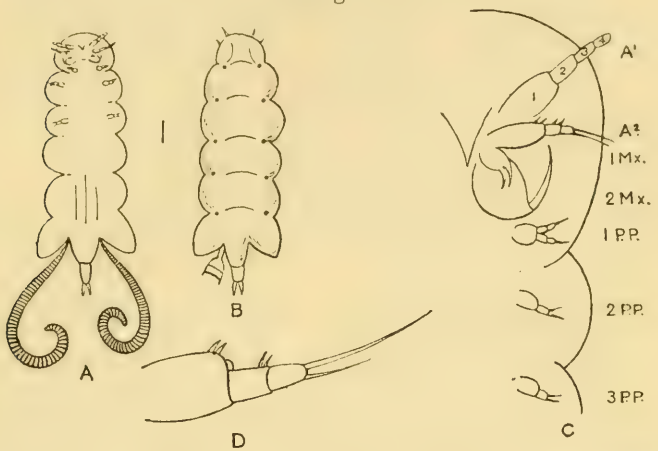
Abdomen biarticulate, narrow, one-sixth the total length, the last joint terminating in two small caudal plates provided with a marginal fringe of short bristles. External ovaries long, spiral, springing from papillæ at the angle of the genital segments and abdomen. Ova large, arranged uniserially as in the Caligidæ.

Anterior antennæ 4-jointed, non-setose, the first joint being the longest and broadest, rising from the underside of the head just in front of the mouth; second, third, and fourth joints progressively decreasing in size.

Posterior antennæ 3-jointed, rising just in front of the upper lip; at the distal end and anterior border of the first and second joints are two short setæ, the third terminating in two bristles, the anterior being very long.

Mouth and appendages placed rather far back; the labrum is triangular, projecting backwards; labium simple, rounded. I was able to make out only 2 pairs of maxillipeds; the first very small, biarticulate, terminating in two short hairs: the second uncinate, with large globose basal joint, to which was articulated a sharp curved claw.

Text-fig. 12.



Ventriculina crosslandi ♀, gen. & sp. n. A. Ventral surface, × 10. B. Dorsal surface. C. Ventral surface much enlarged, showing articulate appendages. D. Posterior antennæ.

Only three pairs of thoracic limbs present: the first rising from the posterior under surface of the cephalic segment, minute, biramose, each ramus terminating in a single bristle; second and third pairs uniramose, made up of two articulations, the distal terminating in two small bristles.

♂ not known.

ADDENDA *to Systematic Enumeration of Species of Parasitic Copepoda found on Fish* (Proc. Zool. Soc. 1899, p. 438).

ERGASILIDÆ.

1. *Eucanthus marchesettii* Valle, Atti Mus. Civ. Trieste, vii. p. 245 (1885). On *Motella tricirrata*.
2. *Ergasilus centrarchidarum* Wright, Proc. Canad. Inst. (2) i. p. 243 (1883).
3. *Ergasilus biuncinatus* Gadd. Meddelanden af Societas pro Fauna et Flora Fennica, xxvii. pp. 181–182 (1901). On *Gastrosteus aculeatus*.

4. *Bomolochus onosi* T. Scott, 20th Ann. Rep. Fish. Board of Scotland, p. 289, pl. xiii. figs. 19–22 (1902). On *Onos mustelus* and *Onos cimbrius*, Firth of Forth.
5. *Bomolochus zeugopteri* T. Scott, *loc. cit.* p. 290, pl. xiii. figs. 23–25. On *Zeugopterus punctatus*.

Caligidæ.

6. *Caligus pacificus* Gissler, Amer. Nat. p. 886 (1883). On *Salmo*.
7. *Caligus labracis* T. Scott, *l. c.* p. 291, pl. xiii. figs. 26–29. On *Labrus mixtus* and *L. maculatus*.
8. *Anchicaligus nautili* Stebbing, Willey's Zool. Res. pt. v. pp. 667–670, pl. lxxi.
9. *Dinematura musteli lævis* Hesse, Rev. Sci. Nat. Montpellier, (2) ii. pp. 6, 11 (1880).
10. *Cecrops acanthiæ vulgaris* Hesse, Ann. Sci. Nat. (6) xv. 3, p. 26 (1883).
11. *Pandarus carcharii glaucus* Hesse, *l. c.* p. 18.
12. „ *musteli lævis* Hesse, *l. c.* p. 23.
13. „ *spinacis acanthiæ* Hesse, *l. c.* p. 10.
14. „ *unicolor* Hesse, *l. c.* p. 20. On *Galeus vulgaris*.

Dichelesthiidæ.

15. *Lernanthropus polynemi* Rich. Zool. Anz. iv. 1881, p. 505. On *Polynemus*.
16. *Lernanthropus tetradactylus* (probably *L. trifoliatus* B.-S. 1898).
17. *Lernanthropus micropterygis* Rich. Atti Soc. Tosc. Sci. Nat. iv. p. 82 (1884). On *Micropteryx dumerili*.
18. *Lernanthropus tylosuri* Rich. *l. c.* p. 83. On *Tylosurus imperialis*.
19. *Kröyeria (Lonchidium) galii vulgaris* Hesse, Ann. Sci. Nat. (6) xvi. 3, p. 2 (1883).
20. *Clavella cluthæ* T. Scott, *l. c.* p. 292, pl. xii. figs. 26–31. On *Ctenolabrus rupestris*.
21. *Pagodina (Nemesis) charchariæ glauci* Hesse, *l. c.* p. 13.
22. *Eudactylina carchariæ glauci* Hesse, *l. c.* p. 11.
23. „ *musteli lævis* Hesse, *l. c.* p. 8.
24. „ *squatina angeli* Hesse, *l. c.* p. 5.
25. „ *similis* T. Scott, *l. c.* p. 295, pl. xii. figs. 1–19. On *Raia radiata*.
26. *Eudactylina acanthii* T. Scott, *l. c.* p. 296, pl. xiii. figs. 1–9. On *Squalus acanthias*.
27. *Bassettia congri* Stebbing, Willey's Zool. Res. pt. v. pp. 671, 672, pl. lxx.

Philichthyidæ.

28. *Philichthys fialolæ* Rich. Zool. Anz. iii. p. 69 (1880). On *Stromateus fialola*.
29. *Philichthys doderleini* Rich. Zool. Anz. vi. p. 558 (1883). On *Labrus turdus*.

LERNÆIDÆ.

30. *Lernœa abyssicola* Brady, Chall. Rep. viii. p. 137. On *Ciralias uranoscopus*.
31. *Lernœa minuta* T. Scott, 18th Rep. Fish. Board of Scotland, p. 161, pl. vii. fig. 13 (1900). On *Gobius minutus*.
32. *Lernœa lumpi* T. Scott, 19th ditto, p. 128, pl. vii. fig. 12 (1901). On *Cyclopterus lumpus*.
33. *Hœmobaphes ambiguus* T. Scott, 18th ditto, p. 162, pl. vii. fig. 15. On *Callionymus maculatus*.
34. *Peraderma petersi* Rich. Zool. Anz. iv. 1881, p. 387. On *Gobius buccatus*.
35. *Peraderma bellottii* Rich. Zool. Anz. v. 1882, p. 475. On *Scopelus benotti*.

CHONDRACANTHIDÆ.

36. *Chondracanthus bleekeri* Rich. Zool. Anz. iv. p. 387 (1881). On *Chilium chlorurus*.
37. *Chondracanthus ninnii* Rich. Zool. Anz. v. p. 504 (1882). On *Gobius*.
38. *Chondracanthus ornatus* T. Scott, 20th Ann. Rep. Fish Board of Scotland, p. 298, pl. xiii. fig. 34. On *Callionymus maculatus*.

LERNÆOPODIDÆ.

39. *Achtheres sandræ* Gadd. Med. af Soc. pro Fauna et Flora Fennica, xxvii. (1901).
40. *Lernœopoda extumescens* Gadd. *l. c.* On *Coregonus*.
41. *Tracheliastes gigas* Rich. Zool. Anz. iv. 1881, p. 504.
42. *Charopinus dubius* T. Scott, 19th Ann. Rep. Fish Board of Scotland, p. 130, pl. vii. fig. 15. On *Raia circularis*.

5. On the Original Home of the Tiger.

By Col. C. E. STEWART, C.B., C.M.G., C.I.E.[1]

[Received December 6, 1902.]

The ordinary idea of English people that the Tiger was originally an Indian animal, is, I believe, quite a mistake. After careful enquiry, I have come to the conclusion that the Tiger is a comparatively late intruder into India.

Firstly, after enquiry, I can discover no Sanscrit word for the Tiger. If tigers had existed in India in the days when Sanscrit was a spoken language, there would be a name in Sanscrit for it, while there is only a modern Hindustani name. There is a Sanscrit word for Lion, "Singha," which would point to the fact that lions were certainly more common than tigers in time long past. At present lions are not found in India, except a very few, which are strictly preserved in Googerat, one extreme

[1] Communicated by Col. HILL JAMES, F.Z.S.

corner of India, though I will allow that lions were probably commoner than they are now in the olden time, though probably never very numerous.

I remember, when I first went to India, nearly 50 years ago, a lion being killed not very far to the southward of Allahabad, but this was even then a rare occurrence. I have studied the question of the habitat of lions and tigers in Persia, where I resided for a good many years. Lions are found only in the very south of Persia, near the Persian Gulf, and Arabia; while tigers are only seen in the very north of Persia, near the Russian border, and especially near the Caspian Sea, on the north of Persia, and they are more numerous within British territory than within the Persian boundary, and tigers are more common in Southern Siberia than they are anywhere in Persia.

Tigers are more numerous in cold countries. They are plentiful in Corea, which has a severe winter climate, and still more plentiful in the Island of Saghalien, belonging to Russia, and further north than Corea, and which has almost an arctic climate in winter. The tiger is mentioned by Marco Polo in his travels, but nowhere as an Indian animal, and I very much doubt whether tigers were found in India at the time Marco Polo visited it.

In the Sanscrit works treating of the fighting between Rama and Rawun, the Demon King of Ceylon, though many animals are mentioned, such as bears, monkeys, and several others, I have been unable to find any mention of the tiger; and the tiger is not found in the Island of Ceylon, though the leopard is; nor is the tiger found in the larger island of Borneo, which would seem to point to its only inhabiting the islands of the Indian Archipelago, which it could reach by swimming. Thus it would seem that tigers did not exist in India before the time that Ceylon was separated from India. Tigers did not exist in the island of Singapore until about 1809, when apparently they swam over from the mainland. Tigers are such good swimmers that they can cross a considerable body of water. I do not think any allusion to tigers in India can be found in the Greek historians. I should feel much obliged if anyone could find me such a reference.

In the monuments of the Assyrian Kings, and of the Kings of Persia, there are constant references to lion-hunts by those kings, but never allusion to a tiger-hunt. Of course there is an existing Persian word for tiger, but there is nothing to show that it is at all ancient.

My own idea is that the tiger was originally a purely northern animal, which has gradually extended southward. I fancy that no allusion to a tiger in India can be traced to a period anterior to the early Mahommedan conquerors of India. I should be much obliged to anyone who will help me to clear up this question. We English have so completely assumed the idea that the tiger is an Indian animal, that we have called him the Royal Bengal Tiger, though I firmly believe he is as much an intruder from the north into Bengal as we are ourselves.

6. On the Mode of Copulation of the Indian Elephant. By H. Slade, Conservator of Forests, Maymyo, Burma.[1]

[Received December 15, 1902.]

Some few months ago I was, on several occasions, able to witness tame Elephants in the act of copulation. This sight has been so seldom witnessed by Europeans, and is so variously described by Burmans, that these remarks, supported by a series of photographs deposited with the Society, may be of interest and value.

As tuskers are usually reputed to be shy of copulating before eye-witnesses, an account of the manner in which these photographs were procured may be interesting.

I was in camp at the time with one tusker and four female Elephants, which were being used regularly for transport purposes. From the time the tusker was reported to be seeking the company of the females he was never let loose to graze, but was kept tied up. I had promised the Burmese mahouts liberal rewards if they would assist me in procuring some "snap-shots"; and one day last February one of them came to tell me the tusker was showing undoubted excitement; he was reported to have been tugging at his chain and looking "nastily" at his keeper. There were, however, absolutely no signs of "must" and no exudation of fluid from the hole in the temple.

The tusker was said to have shown a preference for one of the females that had calved about 12 months previously. So I had her tethered fore and aft in a small glade, and erected my camera quite in the open, about 10 yards off. Having focussed her and got everything ready, the tusker was quietly ridden up behind the female, and as the mahout slipped off, he slowly advanced towards her. However, this was evidently the wrong female, for on the approach of the tusker she showed most unmistakable signs of fear by persistently screaming and straining at her chain. The tusker was therefore secured, and this female marched off, whilst one of the others was caught and tied up in her place. The tusker was then again brought out, and immediately proceeded to mount the female.

I had many opportunities of witnessing the operation, and the following is a general description:—The female, when in season, remains perfectly still and quiet, merely signifying her sense of the tusker's approach by moving her tail slightly to one side and gently shifting her hind feet a few inches further apart. The tusker creeps up behind the female and begins to show signs of sexual excitement. He then raises his head and lightly places his tusks on the female's back, one on either side of her backbone, with his trunk lying along the dorsal ridge and reaching to her shoulder. In this position he remains a length of time, varying with his state of sexual excitement. From my observations I am convinced that when he has unrestricted access to females, and is

[1] Communicated by the Secretary.

not therefore greatly excited, he may remain a very considerable time in this position: this has probably given rise to the tales that are told of the great length of time occupied by the act of copulation, which I have heard put at two hours.

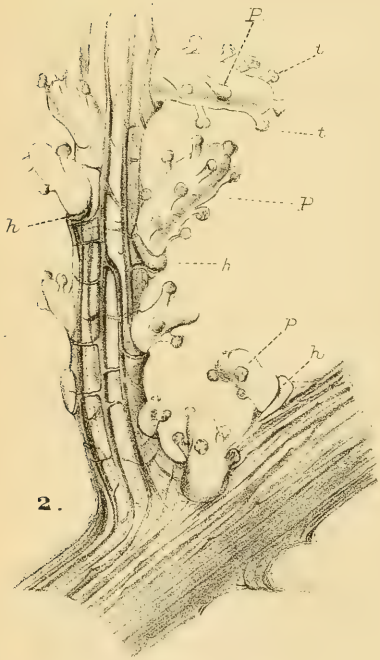
Eventually, however, the time arrives when the tusker proceeds to action. First one fore foot, and then the other, is lifted off the ground, and slowly swung from side to side across his front, exactly as though he were deliberating from which foot to take off. Then, levering himself up by his tusks, he places both fore feet on the female's flanks, at the same time sinking down on his hind legs to an almost sitting position. It is at this moment that he shows the most violent sexual excitement. His organ, which up till now has been bent back in the form of an arc, with its end near the ground, and a few inches only in front of his hind feet, is shot forward, and jerked up and down in a most violent manner. It is flourished in the air, and often bent into the form of an S like the thong of a whip, during which semen may or may not be emitted. At one moment the organ appears outside the tusker's shoulder, the next it is seen protruding out behind his hind legs. It is kept in a state of continual agitation, and not for one single moment is it still. Eventually it is jerked up straight forward and hits the female organ from below. Penetration is then immediately effected without further difficulty. The tusker then raises himself until his hind legs are quite straight, his organ is pushed home, and his fore feet are slid along the female's back until they rest on her shoulders. Arrived at this position, he begins to work very much after the fashion of a dog, and I usually counted from six to eight horizontal motions. Connection being then complete, the tusker lifts his tusks off the female's back and raises his head into the air. In this position he remains for a few seconds, and then slowly withdraws his organ, letting himself gently down to the ground in the same way that he mounted, and quietly moves off. It is then that the female shows her only signs of excitement: she trumpets softly as with pleasure, thrusts forward her ears and stiffens her tail, her whole conduct being indicative of pleasure and pride. The tusker is throughout perfectly silent.

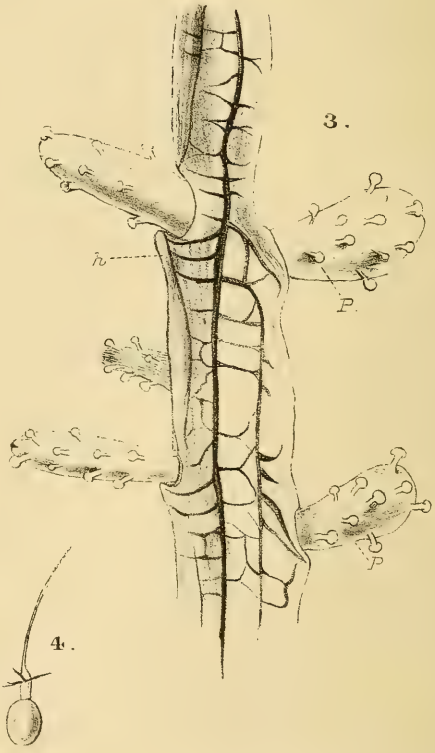
It is noteworthy that at no time does the tusker use his fore legs to steady himself or to grip the female as does a dog or a stallion; the feet are invariably kept close together on the top of the female's back, and I can quite believe the statement of the Burmans that it makes no difference whether his feet are fettered or not.

I was unable to distinguish any sign by which I could tell when a female was in season, but three out of the four females in camp did come into season during the period of 10 days in February during which they were under observation.

The operation was accurately timed on one occasion, and was found to last exactly one minute.

From my own observations, I am convinced it is the female that comes in season, and that until she does so come the tusker





E.D & S.J.H. del.

Bale & Danielsson Ltd lith.

CERATELLA MINIMA.

will take no notice of her: also that he is ready whenever she is. I can offer no opinion as to whether the companionship of the tusker tends to bring the female into season or not.

I must draw attention to the way in which both the tusker and female absolutely ignored our presence. As I have already stated, the camera was set up within 10 yards of the tethered female, quite out in the open without any attempt at concealment; and though there were sometimes six or eight spectators walking about and talking within this short distance, on no occasion did either the tusker or the female take the slightest notice of us or even look our way. Directly the act of copulation was over, the mahout called out to the tusker, who, at the word of command, came towards him, knelt down, and allowed himself to be mounted and ridden off.

As I have said, the female was always tethered fore and aft with a long chain, but this was solely with the object of preventing her swinging round and so getting out of focus; but in no single instance did she attempt to do this, nor was the chain once needed except, of course, in the case of the first female who was not in season.

7. On the Cœlenterata collected by Mr. C. Crossland in Zanzibar.—I. *Ceratella minima*, n. sp. By Sydney J. Hickson, M.A., F.R.S., F.Z.S., Beyer Professor of Zoology in the Owens College, Manchester.

[Received December 16, 1902.]

(Plate XIII.[1])

Our knowledge of the remarkable family of Hydrozoa, the Ceratelladæ, has been ably summarized in the memoir published by Prof. Spencer in the Transactions of the Royal Society of Victoria, 1892 (4). The hitherto recorded species are distributed as follows:—*Ceratella fusca*: Coogee, Bondi (N.S.W.), Broughton Island, Flinders Island, Lord Howe Island. *C. procumbens*: Cape of Good Hope, Natal. *C. spinosa*: Port Natal. *Chitina ericopsis*: New Zealand. *Dehitella atrorubens*: Delagoa Bay. In brief, the family has hitherto been known to occur only in Australasian and S. African waters.

The discovery of a new species of the genus *Ceratella* in the tropical waters of the Zanzibar coast is in itself worthy of note, but especially so in view of the fact that it is associated with corals, alcyonarians, and other animals characteristic of the tropical belt of the East African coast. I am indebted to Mr. C. Crossland, of Clare College, Cambridge, who collected the three specimens during his recent expedition to Zanzibar, for permission to examine and describe them.

The African species of the family have not yet been accurately described, but the accounts of Gray (1) and Carter (2) are

[1] For explanation of the Plate see p. 116.

sufficient to show that the Zanzibar specimens should be described as belonging to a new species.

They appear to be most closely related to the Australian species *Ceratella fusca*, but differ from it in one or two characters which Spencer and his predecessors regarded as of generic importance.

The genus was defined by Spencer as follows:—Colony irregularly branching; more or less expanded in one plane; growing from a creeping base. Main stem flattened, branches rounded and beset with bracket-like hydrophores.

In *C. minima* from Zanzibar the main stem is not flattened but perfectly cylindrical in form, and the hydrophores are so extremely reduced or rudimentary that they are little more than ridges on the proximal lips of the hydropores. The branching, moreover, appears to be strictly in one plane, and the terminal branches are much more slender and delicate than in the other species. Before passing on to the specific characters, the size of the specimens must be considered.

The measurements are as follows:—

	Specimen A. mm.	Specimen B. mm.	Specimen C. mm.
Height of the colony	29	22	35
Maximum expanse of the branches	65	38	50
Diameter of main stem	1·2	0·75	1

The colonies of *Ceratella fusca* are from $1\frac{1}{2}$ to 5 inches in height; the largest specimens of *C. procumbens* described by Carter were 11 inches long by 5 inches broad, and of *C. spinosa* $4\frac{1}{2}$ inches long by 2 broad. The height of *Chitina ericopsis* is 14 inches, with a trunk (main stem) 1 inch in diameter. The size of *Dehitella* is not given by Gray, but from the figures it may be judged that it is larger than *Ceratella fusca*. From these figures it is clear that the Zanzibar specimens are much smaller than the average size of the adult colonies of the other species. Are they, therefore, to be regarded as young colonies or as the representatives of a dwarf species? If they are young colonies, it is quite possible that the main stem or trunk becomes somewhat compressed in the plane of branching as the colony grows; but the fact that all the three specimens obtained are of approximately the same size, suggests that they have reached or nearly reached their maximum growth. The dwarfing of the tropical species of a genus that is principally distributed in temperate waters is not without parallel in the group of Cœlenterata. The very rudimentary character of the hydrophores, however, cannot be explained by the suggestion of immaturity, and must be regarded as of specific importance. It is true that no gonophores have been discovered in the specimens, but it is quite probable that, as in other Cœlenterates of the tropics, their production is rapid and strictly seasonal, so that no argument can be deduced from this character, either for or against the theory of juvenility.

The Colony.—The branching is not very profuse, and strictly

confined to one plane (Pl. XIII. fig. 1). The main stem and the larger branches seem to have divided dichotomously with the predominance of the most favoured branch. The terminal branches are very delicate, branches of 6 mm. in length gradually attenuating from 0·2 mm. to 0·1 mm. in diameter. Each terminal branch ends in a facultative growing point, and it appears probable that the growth is continuous. I have compared my specimens from Zanzibar with a beautifully preserved specimen of *Ceratella fusca*, for which the Manchester Museum is indebted to Prof. Spencer; and I have noticed that the Australian species is much coarser in appearance, especially in the region of the terminal branches. I have seen nothing in the Zanzibar species corresponding to what Spencer calls "The growing ends of the smaller branches" in *Ceratella fusca*, which are flattened in a plane at right angles to that in which the general growth takes place and are entirely devoid of zooids. It is possible that the difference may be accounted for on the supposition that in *Ceratella fusca* the growth is seasonal or periodic.

The branches of *C. minima* are invariably rounded. I have seen no evidence of a compression or flattening in any region. The surface is relatively smooth and free from any spines. The hydrophores are represented by very narrow ridges on the proximal border of the hydropores. The principal horny fibres, running longitudinally with a slightly spiral twist, may be clearly seen through the superficial ectoderm, and in the spirit-specimens give a ribbed appearance to the surface (Pl. XIII. fig. 2).

The *Zooids* are numerous on the terminal branches, less numerous on the thicker branches, and very scarce on the main branches, as in *Ceratella fusca*. On the terminal branches they are arranged slightly to one side of the two lateral lines at intervals of about one millimetre opposite or alternate to one another. A few zooids occur more irregularly distributed.

On comparing such a terminal branch with one of *Ceratella fusca*, it is at once apparent that in the Australian species the zooids are more numerous and much more irregularly distributed on all sides of the branch. Each fully expanded zooid projects about 0·7 mm. from the hydropore, and is about 0·14 mm. in diameter. It bears a variable number, but usually nine capitate tentacles, each about 0·1 mm. in length.

No gonophores were found on any of the three specimens I have examined. The skeleton in the terminal branches consists of one or two main longitudinal horny rods supporting numerous looping and irregular bands, which maintain the cylindrical form of the branch (Pl. XIII. fig. 3).

In the larger branches the main longitudinal rods are more numerous, and, being chiefly superficial in position, give a slightly spiral, longitudinally striated or ribbed appearance to the surface, in this respect offering a marked contrast to *Ceratella fusca*.

A series of sections through a small branch shows that there is present a thin continuous coat of ectoderm covering the whole branch, as described and figured by Spencer in *Ceratella fusca*.

The arrangement of the canals and the general histology does not appear to differ materially from the description given by the same author; but as the state of preservation of the Zanzibar specimens was not perfect, a detailed and critical examination of the sections was not made. I was fortunate enough to find, however, a few nematocysts that were exploded but remained *in situ*. They are (Pl. XIII. fig. 4) very similar in form to the small nematocysts of *Millepora*, and exhibit a vesicle and neck 0·01 mm. in length, armed with four barbs or spines. The thread was invariably broken, and I have no means of measuring its extreme length.

The endoderm of the tentacles is solid.

The diagnosis of the species is as follows:—

Ceratella minima, sp. nov.

Colony probably erect, branching strictly in one plane, irregularly and not very profusely. The main stems and all the branches cylindrical in form. Hydrophores very slightly developed. Skeleton consisting of dark brown longitudinally disposed horny fibres, united by loops and bands, forming in the larger branches a dense and firm but flexible skeletal plexus.

Zooids situated slightly to one side of the plane of branching of the colony, alternately or in pairs, at distances of about 1 mm. on the terminal branches. Largest colony 29 mm. in height, with a maximum expanse of 65 mm.

Locality. Zanzibar, shallow water.

Literature.

1. J. E. Gray.—Notes on the Ceratelladæ, a Family of Keratose Sponges. Proc. Zool. Soc. 1868, p. 575.
2. H. J. Carter.—Transformation of an entire Shell into Chitinous Structure by the Polype *Hydractinia*, with short descriptions of the Polypidoms of five other species. Ann. & Mag. Nat. Hist. ser. 4, 1873, xi. p. 1.
3. W. M. Bale.—Some new and rare Hydroida in the Australian Museum. Proc. Linn. Soc. N. S. Wales, 1889, p. 748.
4. W. B. Spencer.—On the Structure of *Ceratella fusca*. Trans. Royal Soc. of Victoria, 1892, p. 8.

EXPLANATION OF PLATE XIII.

Fig. 1. Drawing of the whole colony of *Ceratella minima* (specimen A) twice the natural size. The base of attachment is covered by an encrusting polyzoon.

Fig. 2. A portion of a large branch and smaller branchlet taken from the region marked * in fig. 1, more highly magnified, showing the polyps P partially extended, bearing an irregular number of knobbed tentacles, *t.t.* At *h.h.* are seen the rudimentary hydrophores. The figures show the general arrangement of the fibres of the horny skeleton. In the large branch they are closely crowded together. In the smaller branches the principal fibres are separated by considerable spaces but maintain a parallel arrangement.

Fig. 3. A still smaller branch more highly magnified, in which there is only one primary longitudinal fibre.

Fig. 4. One of the nematocysts of the tentacles. The diameter of the cyst is about 0·01 mm.

8. Contributions to our Knowledge of the Plankton of the Faeroe Channel.—No. VIII.[1] By G. Herbert Fowler, B.A., Ph.D., F.Z.S.

[Received December 20, 1902.]

(Text-figures 13–17.)

The present paper contains notes (in some cases due to the valued help of friends) on *Beroë*, *Arachnactis*, *Podon*, the Ostracoda, the Copepoda, the Amphipoda, and the Schizopoda, captured by H.M.S. 'Research' in 1896 and 1897 in the Faeroe Channel.

Ctenophora.

Beroë cucumis Fabricius.

This species, characteristic of cold Arctic currents [2], was taken in the following hauls :—

16 *a* ii., 300 to 170 fathoms, seven specimens.

13 *e*, 400 to ? fathoms, one fragment.

20 *d*, 500 to 400 fathoms, one specimen.

Most specimens showed the characteristic brick-red or rose tint, and though much battered and in some cases inverted, were referable with a fair amount of certainty to this species.

Anthozoa.

Arachnactis albida M. Sars.

Some information as to the developmental succession of the mesenteries in this form was given in No. III. of this series. Since its publication, I am glad to say that it has been substantially corroborated by Prof. van Beneden [3].

He agrees with my suggestion to separate the Channel and North Sea *Arachnactis* from *albida* of the Faeroe Channel, and describes it under the name of *lloydii*, under the idea, which is probable, but at present unproved, that it will be shown eventually to be the larva of *Cereanthus lloydii*. Till this has been proved, I venture to think it better to retain my provisional name of *bournei* for this form.

The occurrences of *A. albida* are shown in the table (p. 118): it occurred in over 61 per cent. of epiplankton hauls, never in a mesoplankton haul, and may fairly be taken to be a purely epiplankton form. It was present in considerable quantity, as many as 50 specimens having been taken in one haul.

[1] The references to previous papers in the Society's Proceedings are :—No. I., 1896, p. 991; No. II., 1897, p. 523; No. III., 1897, p. 803; No. IV., 1898, p. 540; No. V., 1898, p. 550; No. VI., 1898, p. 567; No. VII., 1898, p. 1016. I regret that various circumstances, mostly beyond my control, have caused so great a lapse of time between this paper and No. VII.

[2] Chun : 'Die Ctenophoren der Plankton-Expedition,' p. 26.

[3] Van Beneden : 'Anthozoaires de la Plankton-Expédition.'

	Station Number and Haul Letter.	Horizon in fathoms.	*Beröe cucumis* Fabr.	*Arachnactis albida* M. Sars.	*Podon intermedius* Lilljeborg.	*Conchœcia maxima* Br. & Norm.	*Calanus finmarchicus* Gunner.
Epiplankton.	11 *a*.	100–±0	...	...	...	...	+
	11 *b*.	0	...	+	...	...	+
	11 *c*.	30–0	...	+	...	...	+
	12 *b*.	10–0	...	...	+	...	+
	12 *c*.	0	...	+	+	...	+
	12 *d*.	130–±0	...	...	...	...	+
	12 *f*.	? 10–0	...	+	...	...	...
	13 *c*.	2–0	...	+	+		
	13 *f*.	0	...	+	+		
	13 *h*.	0					
	13 *i*.	100–0	...	+	+	...	+
	13 *k*.	2–0	...	+	+	...	...
	13 *l*.	0					
	14.	0	...	...	...	...	+
	15 *a*.	2–0	...	...	...	...	...
	15 *b*.	0	...	+	...	...	+
	15 *d*.	0	...	...	...	...	+
	16 *b*.	0	...	...	...	...	+
	16 *c*.	4–0	...	+	...	...	+
	17.	0					
	18 *a*.	3–0	...	+	+	...	+
	19 *c*.	4–0	...	+	...	...	+
	19 *d*.	10–0	...	+	...	...	...
	20 *e*.	0	...	+			
	20 *f*.	0	...	+	...	...	...
	20 *g*.	40–0	...	...	...	...	+
Mesoplankton.	12 *a*.	±350–±150	...	...	...	...	...
	12 *e*.	450–320	...	...	...	...	+
	13 *d*.	400–270	...	...	...	...	+
	13 *g*.	465–335	...	...	...	+	+
	16 *a* i.	350–220	...	...	...	+	+
	16 *a* ii.	300–170	+	...	...	...	+
	18 *b*.	530–400	...	...	...	...	+
	19 *a*.	480–350	...	...	...	+	+
	20 *a*.	200–100	...	...	...	+	+
	20 *b*.	300–200	...	...	...	...	+
	20 *c*.	400–300	...	...	...	+	+
	20 *d*.	500–400	+	...	+	+	+
Doubtful.	13 *a b*.	300–0	...	+	...	+	+
	13 *e*.	400–?	+	+	...	+	+
	15 *c*.	530–0	...	...	...	+	+
	19 *b*.	480–0	...	+	...	...	+

| | | |

Phyllopoda.

Podon intermedius Lilljeborg.

My friend the Rev. T. R. R. Stebbing, F.R.S., was kind enough to identify and count the specimens of this species. It would no doubt have occurred in more of the surface hauls had not my finest tow-net been devoted to the collection of Diatoms for the Scottish Fishery Board. It is no doubt a purely epiplanktonic form in the Faeroe Channel; a single specimen only was taken at 20 *d* (500–400 fathoms) as against about 106 specimens in 7 hauls at the surface; the single deep specimen was probably a sinking corpse.

This species is, I believe, known only from the surface[1]; it ranges over the Baltic, Norwegian coast up to Vadsö, Denmark, Boulogne, Concarneau, Trieste.

Ostracoda.

The representatives of this order belonged exclusively to the Halocypridæ, and were mostly taken in the mesoplankton. Only one species, *Conchœcia maxima*, occurred sufficiently often to allow of a generalization as to its horizon.

The identification of a Halocyprid is rarely satisfactory without dissection of the mouth-parts, which means destruction of the specimen. I have, however, dissected a considerable number, and feel at all doubtful only in the case of *C. porrecta*; I have preferred, however, to leave the specimens under this species rather than create a new species on the strength of slight differences in the armature of the mandible.

The table following shows those surface and deep-water hauls, made by Professor Chun between Finistère and the Canary Islands with open vertical nets[2], which contained the same species as

Haul.	Horizon in fathoms.	*Conchœcia hyalophyllum.*	*Conchœcia porrecta.*	*Paraconchœcia oblonga.*	*Halocypria globosa.*	*Conchœcilla daphnoides.*
II.	546 to 0	...	*	...	Various depths.	...
III.	819 to 0	...	*	*		*
IV.	546 to 0	*	*	*		*
VII.	873 to 0	...	*	...		...
	Surface.	...	...	*	*	...

[1] J. de Guerne: Bull. Soc. Zool. France, xii. 341 (1887). W. Lilljeborg: 'Cladocera Sueciæ,' Upsala, 1900, 4to.

[2] Chun: SB. kön. preuss. Akad. Wissensch. (1889 xxx. Claus: 'Die Halocypriden,' Wien, 1891, 4to.

were captured by the 'Research' in the Faeroe Channel; they are cited in the text by Roman numerals.

Conchœcia maxima Brady & Norman.

As I have previously pointed out[1], this species appears to be purely mesoplanktonic, in the latitude at any rate of the Faeroe Channel. It occurred in 50 per cent. of the mesoplankton hauls, and in three hauls which began at or over 300 fathoms and finished at the surface; it was not captured once in hauls between 100 fathoms and the surface (*cf.* table, p. 118). The species was fairly common.

The record of previous captures was cited in the second paper of this series[1], and also indicated a mesoplanktonic habit in subarctic regions, but it is not surprising that in yet colder waters it should appear at the surface. At 84° 32′ N., 76° E., it was captured with a surface-net by the 'Fram'[2], and is recorded as abundant in most of the samples of Crustacea from this voyage[3].

Conchœcia hyalophyllum Claus.

Twelve specimens in haul 13 *i*, 100 fathoms to surface. Five specimens too small for satisfactory identification, but perhaps referable to this species, occurred in hauls 20 *c* and 20 *d*.

Claus[4] records as other occurrences Chun's haul IV., Ischia at 492 fathoms, Orotava at the surface.

? Conchœcia porrecta Claus.

Numerous specimens from 20 *a b c d* and one from 13 *i*. Claus (*op. cit.*) records it from Chun's hauls II., III., IV., VII.

Conchœcia borealis G. O. Sars.

A single specimen in haul 19 *a*, 480 to 350 fathoms. Recorded previously from 250 to 300 fathoms at the Lofoten Islands[5], and from Trondhjem Fjord at 150 fathoms[6]. This appears to be a purely cold-water form.

Paraconchœcia oblonga Claus.

Six specimens in haul 20 *c*, four in 20 *d*. Claus (*op. cit.* p. 64) cites this species as from Chun's hauls III. and IV.; and states that it also occurs at the surface, but without giving authority or details. He remarks on the probable identity of this species with G. W. Müller's *variabilis*[7], a suggestion with which Müller seems to agree[8]. This would extend the distribution considerably, as Müller[7] records it, from the 'Vettor Pisani' collections of

[1] Proc. Zool. Soc. 1897, p. 523.
[2] F. Nansen: Norwegian North Polar Expedition. G. O. Sars: Crustacea, p. 11.
[3] *Id. ibid.* p. 137.
[4] C. Claus, *op. cit.* p. 61.
[5] G. O. Sars: Forh. Vid.-Selsk. Christiania (1865), vol. 1866, p. 120.
[6] G. S. Brady & A. M. Norman: Trans. Roy. Dublin Soc. (2) v. p. 686.
[7] G. W. Müller: "Ueber Halocypriden," Zool. Jahrb. Syst. v. p. 273.
[8] G. W. Müller: 'Ostracoden des Golfes von Neapel,' p. 229.

Chierchia, as occurring at various points in the tropics at depths between 382 and 546 fathoms; it occurs also in the Gulf of Naples. Brady[1] records it as having been taken by the 'Challenger' Expedition off Kandavu, Fiji, and between Marion and Crozet Islands at unrecorded depths.

Halocypria globosa Claus.

Six specimens in haul 13 *i*.

This species is known from the surface and at various depths in the Atlantic[2], and is recorded from Gibraltar as taken by the 'Vettor Pisani'[3]. Of specimens taken by the 'Challenger,' the record was in one instance lost[4]; other specimens were captured at the surface between Api and Cape York[5]. It seems to be a form widely distributed both vertically and horizontally.

Conchœcilla daphnoides Claus.

Only three complete specimens, and one empty carapace, referable to this genus were obtained. The specimens on which Claus founded the genus (with this single species) were all young males: larger specimens of the genus, including females, were obtained by Sir John Murray on H.M.S. 'Triton' in 1882, from the Cold Area of the Faeroe Channel, and were described by Canon Norman and Dr. Brady under the specific name of *lacerta*, not without the "suspicion that they may perhaps belong to the adult form of *C. daphnoides*"[6]. My own specimens were too few to settle the point; but as the two smaller specimens most resembled in outline the figure of Claus, and the two largest that of Brady and Norman, I have left them provisionally under the older specific name.

In addition to Chun's hauls III. and IV., it has been captured at 200 fathoms off Achill Head (*daphnoides*), the Faeroe Channel as above (*lacerta*), and off Kandavu, Fiji, at an unrecorded depth[7] (*daphnoides*).

Copepoda.

Mr. I. C. Thompson was kind enough to report on the Copepoda in No. IV. of this series of papers[8]. Since that date, the arrangement of three then doubtful hauls has required modification: 12 *a*, which was suspected at the time of capture to have remained open too long, proves to have no apparent contamination of undoubted surface forms, and has been moved to the Mesoplankton; 13 *e* was also suspected, in this case with justice, as

[1] G. S. Brady: "Myodocopa of the 'Challenger' Expedition," Trans. Zool. Soc. xiv. p. 95.
[2] C. Claus, *op. cit.* p. 79.
[3] G. W. Müller: Zool. Jahrb. Syst. v. p. 270.
[4] G. S. Brady & A. M. Norman: Trans. Roy. Dublin Soc. (2) v. p. 705.
[5] G. S. Brady: Trans. Zool. Soc. xiv. p. 97.
[6] G. S. Brady & A. M. Norman: Trans. Roy. Dublin Soc. (2) v. p. 697.
[7] G. S. Brady: Trans. Zool. Soc. xiv. p. 95.
[8] Proc. Zool. Soc. 1898, p. 540.

containing several undoubtedly epiplanktonic species (e. g. *Arachnactis albida*), and has been relegated to the "doubtful" category, closure of the net not having taken place at the proper time; 12*f* was known to be epiplanktonic, although there was some doubt as to the exact depth at which it had been towed. I have therefore reprinted in the table (pp. 118, 119) the captures of the seven forms which were taken at least six times, sufficiently often to give approximate data for an estimate of their vertical distribution. In discussing this question, I gave a short table on p. 546 showing the occurrences of these seven species expressed in percentages of those Epiplankton and Mesoplankton hauls which contained Copepoda; this can now be amended as follows, omitting the four doubtful hauls from the calculation:—

	Total hauls containing Copepoda.			
	Epiplankton.		Mesoplankton.	
Calanus finmarchicus occurred in	83 %	and in	91 %	
[1] *Eucalanus attenuatus* „	22 „	„	41 „	
Euchæta norvegica „	11 „	„	75 „	
Metridia longa „	22 „	„	75 „	
[1] *Pleuromma abdominale* „	5 „	„	58 „	
Acartia clausii „	33 „	„	25 „	
Temora longicornis „	33 „	„	0 „	

The amended table is in harmony with the conclusions drawn from the former, as to the vertical distribution of these forms, except in the case of *Acartia clausii*, the question of which was expressly reserved (*op. cit.* p. 549).

Since the publication of Mr. Thompson's report, I found that Dr. R. Norris Wolfenden was making an exhaustive study of the fauna of the Faeroe Channel, and naturally placed my collection at his disposal. He has been kind enough to furnish the following notes on new and other species, with some of which he has already dealt briefly elsewhere [2]. Exact data of depth &c. were not always available, as by the time that Dr. Wolfenden received the specimens all the epiplankton hauls of a station had in many cases been put together in one bottle, all the mesoplankton hauls in another, for economy of space.

Pleuromma robustum Dahl, Zool. Anzeig. v. p. 16 (1893).

"This is the common *Pleuromma* of the Faeroe Channel, and was found to be present in considerable numbers in Dr. Fowler's collection, *Pl. abdominale* occurring much more rarely. In these northern latitudes it almost entirely replaces the latter species. It is readily distinguishable by the horseshoe-shaped mass of red pigment which is present in the anterior and inferior portion of the head at the base of the mouth-organs, and in the male by

[1] Dr. Wolfenden points out that as, according to his wide experience, *Eucalanus attenuatus* is nowhere met with in the Faeroe Channel, unless perhaps quite exceptionally, these figures probably refer to *Eucalanus elongatus*. Similarly, for the species *Pleuromma abdominale* should probably be substituted *Pl. robustum*.

[2] R. N. Wolfenden: Journ. Marine Biol. Assoc. (1902), vi. p. 344.

the clasping antenna being on the left side, and the pigment-spot invariably on the right side. The second feet in both male and female have the characteristic notch and hook on both limbs. Length 3–4 mm. Haul 20 *a* (200 to 100 fms.) and several others."

Heterochæta zetesios ♂, Wolfenden, *op. cit.* p. 367.

"The head is like *H. papilligera* Gbt. Though the end joints of both anterior antennæ were broken off, the 19 joints left had a length of over 4 mm., with the geniculation between the 18th and 19th segments. The anterior antennæ were therefore much longer than the whole animal, which was 3·5 mm. There was considerable asymmetry of the furcal segments, that on the left being much the longest and broadest. The anterior foot-jaw had one thick hooked bristle on the 5th lobe, but no "tooth-comb" bristle, and the 5th feet were peculiar and unlike those of any other *Heterochæta*, displaying an upright and stiff process of the 2nd basal joint, armed with fine stiff hairs on the inner aspect (like a "tooth-comb"), and the proximal inner margin of the 1st joint of the exopodite with a protuberance armed with 4 teeth. The 2nd basal joint of the foot of the opposite side is armed distally with short stiff bristles. It could be only the male of *H. grimaldii* or of *H. longicornis*, neither of which is yet known, or of *H. major* (Dahl). The latter and *H. grimaldii* are very large (5–10 mm.), and though *H. zetesios* resembles *H. longicornis* in some points, it is perhaps better for the present to distinguish it as a new species. Only one example was met with in Dr. Fowler's collection, in haul 20 *a* (200 to 100 fathoms)."

Ægisthus atlanticus Wolfenden, *op. cit.* p. 364.

"The occurrence of an example of this genus in the Faeroe Channel is remarkable. This specimen was found in the collection made by Dr. Fowler as 20 *a* (200 to 100 fathoms). It had a total length of 1·45 mm., a 6-segmented anterior antenna with very long and peculiar sensory processes. It has distinct differences from *Æg. mucronatus* or *Æg. aculeatus* Gbt., and also from the species described by Scott from the Gulf of Guinea as *Ægisthus longirostris*."

Lucicutia magna Wolfenden, sp. n. ♂.

"A single specimen found in Dr. Fowler's collection from 19 *a* (480 to 350 fathoms), of 3·54 mm. length, was apparently new. The anterior antennæ were larger than the whole body, by the terminal one and a half joints. The endopodite of the 1st foot was two-jointed. The right 5th foot has a strong spiny process on the inner side of the 2nd basal and the exopodite of two segments; the endopodite and exopodite of the left 5th foot being each of three segments. The size alone distinguishes it from the males of any other known species, only *L. grandis* being larger."

Augaptilus zetesios Wolfenden, *op. cit.* p. 369.

"One specimen only was found, in the bottle marked 19 *a.c.* Another specimen occurred in the sample marked 20."

Eucalanus crassus Gbt. 1888, Atti Acc. Linc., and 1892, Fauna u. Flora Neapel, v. p. 19.

"This species was of not infrequent occurrence, especially in the bottles marked B 1 and 13 *k* (2 to 0) and 13 *i* (100 to 0).

"The writer also has frequently noted its occurrence in the Faeroe Channel."

Gaetanus major Wolfenden, sp. n.

"Two examples of this genus (*Gaetanus*) were found in Dr. Fowler's collection marked 19 *a* (480 to 350 fathoms). The copepod very greatly resembled *Gaetanus armiger* Gbt., but the anterior antennæ were longer, reaching beyond the furca by the length of the last joint; the spines of the last thoracic segment were comparatively shorter, the 1st abdominal segment and the anal segment shorter, and the furcal segments only as long as broad (longer than broad in *G. armiger*), and each abdominal segment had a row of pectinations on the posterior border. The saws of the swimming-feet possessed more teeth; the abdomen was not nearly half the length of the cephalothorax, and the whole length of the animal was 5·3 mm. In all these points it differed from the typical *G. armiger*, the size of which reaches only about 3 mm., and justifies its being made into a separate species."

Gaidius Gbt. 1895, Bull. Mus. Harvard.

"A good many examples of this genus occurred in the deep-water collections of Dr. Fowler, *e.g.* in the bottle marked Mesoplankton 20 (500 to 100 fathoms).

There is no doubt that in the Faeroe Channel there are two kinds of *Gaidius*—one agreeing in every particular with the *Gaidius pungens* of Giesbrecht; the other, a larger species, also differing in the segmentation of the 1st and 2nd feet. *Gaidius pungens* Gbt. has the exopodite of the 1st foot with only two segments and the endopodite of the 2nd foot with only one segment; whereas the northern species has a 3-jointed exopodite of the 1st foot and a two-jointed endopodite of the 2nd foot. There are other minor differences. In size the northern species is much larger; *Gaidius pungens* Gbt. being 4½ mm., as compared with about 3 mm. The *Chiridius tenuispinis* of G. O. Sars is the same species, all being characterized by the peculiar series of lamellar appendages of the basipodite of the 4th foot."

Pseudaetideus armatus Wolfenden.

"Some examples of this species occurred in Dr. Fowler's collection. It was drawn and described (in MSS. only) before the

writer became acquainted with the recent work of Prof. G. O. Sars, who figured and described the species as *Chiridius armatus*. The writer has published reasons why this generic name should not be used (see Rep. of the Brit. Assoc. 1892, "A proposed Revision of the Subfamily *Aetidiinæ*"), as it is not a *Chiridius*."

Euchirella carinata Wolfenden, *op. cit.* p. 366.

"One example of this species, measuring 3·54 mm. in length, was found in Dr. Fowler's collection in the bottle marked 20.

"These new species will be described in full, along with the drawings, in the writer's monograph which is in hand."

Amphipoda.

I am indebted to the Rev. T. R. R. Stebbing for help in the determination of some of these forms. Only one species occurred in sufficient quantity and with sufficient frequency to enable deductions as to its habitat in the Faeroe Channel being drawn, namely

Parathemisto oblivia Kröyer = *abyssorum* Boeck.

I have already discussed the distribution of this form at some length [1]; to the records there given must be added two stations of the 'National' expedition—N. of the Hebrides, and S.W. of Iceland [2]—and 12 stations along the route of the 'Fram' [3]. Canon Norman also cites Bonnier as having taken it at 950 metres in the Bay of Biscay [4].

It is apparent from the table (p. 119) that the species is a true member of the Mesoplankton in this locality, having been captured in 66 per cent. of the deep hauls; it rises to the surface at midnight, the only occasion out of 26 Epiplankton hauls being at that hour (haul 15 *d*).

Cyclocaris guilelmi Chevreux.

Two specimens of a *Cyclocaris* were obtained in haul 20 *d*, between 500 and 400 fathoms. Mr. Stebbing informs me that they agree undoubtedly with the above species, captured in a net sunk to 600 fathoms near the Lofoten Islands by the 'Princesse Alice' [5], the largest of the six specimens being about 12 mm. in length. My largest specimen, a female, would have measured about 20 mm. if straight.

Another species of this genus, *Cyclocaris tahitensis* Stebbing, was described [6] from a single specimen taken by the 'Challenger' off Tahiti, apparently at the surface [7].

1 Proc. Zool. Soc. 1898, pp. 583–585.
2 J. Vosseler: Amphipoden der Plankton-Expedition, p. 80.
3 F. Nansen: Norwegian North Polar Expedition. Crustacea, by G. O. Sars, p. 14.
4 A. M. Norman: Ann. Mag. N. H. (7) v. p. 131.
5 E. Chevreux: Bull. Soc. Zool. France, xxiv. (1899), p. 148.
6 T. R. R. Stebbing: Chall. Rep. Zool., Amphipoda, p. 661, pl. xvii.
7 J. Murray: Chall. Rep., Summary of Results, p. 1077.

Mr. Stebbing points out "that this species has been again figured in great detail by Professor Sars [1], and that Dr. Norman [2] has with almost equal fulness represented his *Cyclocaris faroensis*. In Mr. Stebbing's opinion the differences between the two sets of figures are purely casual, depending on individual or accidental conditions of the specimens examined. Further, while accepting provisionally the distinction between the boreal form and the 'Challenger' *C. tahitensis*, he agrees with the view thus expressed by Dr. Norman, 'so remarkable is the resemblance, that the differences seem scarcely varietal; but I hesitate to unite a form found in the Faroe Channel with one from so distant a locality as Tahiti.'"

Canon Norman does not appear to have known of M. Chevreux's name (which apparently has priority); his specimens were captured by the 'Triton' in the Faeroe Channel in 1882, at a depth of 640 fathoms. Professor Sars's specimens were apparently from various depths along the course of the 'Fram,' the smallest specimens at the least depths.

This species (omitting *tahitensis* as specifically distinct) is evidently a Polar and deep-water form.

Tryphana malmi Boeck.

A single specimen, from haul 13 *i*, 100 fathoms to the surface, was identified by Mr. Stebbing. The previous records of its occurrence are: Hardangerfjord, 100 fathoms [3]; from Nansen-fjord to Hardangerfjord [4]; Folgerö, Sunde, Foldenfjord, 80 to 100 fathoms [5]. Sars [5] regards *T. nordenskiöldi* Boeck and *T. boecki* Stebbing as being the males of *T. malmi*. Of these the former [4] was described from the Sofia Expedition as off the Faeroe Islands at 65° N., the latter [6] from 18° 8′ N., 30° 5′ W., at the surface.

Euthemisto sp. indet.

A number of specimens too much broken for recognition occurred in the haul 15 *d* at midnight.

Euthemisto bispinosa Boeck.

Occurred in 15 *c* (530 to 0 fathoms) and 15 *d* (surface, at midnight). The records of this species were exclusively Arctic, till it was captured by the 'National' expedition in the Sargasso Sea between 218 fathoms and the surface.[5]

Euthemisto compressa Goës.

A single specimen at 12 *e* (450 to 320 fathoms). This also was believed to be exclusively an Arctic form, but has now been

[1] F. Nansen: Norwegian North Polar Expedition. G. O. Sars: Crustacea, p. 20, pls. ii. & iii.
[2] A. M. Norman: Ann. Mag. N. H. (7) v. p. 197, pl. vi.
[3] Boeck: 'Skandinaviske og Arktiske Amphipoda,' 1872, p. 92.
[4] C. Bovallius: Vega-Exped. Vetensk. Iakttag. iv. p. 573.
[5] Sars: Crustacea of Norway; Amphipoda, i. p. 17 (1890).
[6] T. R. R. Stebbing: Chall. Rep. Amphipoda, p. 1539.

recorded from the Antarctic region, as well as from the Gulf-Stream proper, the Sargasso Sea, and South Equatorial Drift [1].

Euthemisto libellula Mandt.

A single specimen in haul 15 *d* at the surface at midnight. It is widely distributed over the Arctic Seas, but, unlike the two foregoing species, was not taken in southern waters by the 'National.'

Scina borealis G. O. Sars.

A single specimen from 13 *g* (465 to 335 fathoms) was accidentally included among the Copepoda sent to Mr. Thompson and identified by Mr. A. O. Walker. According to Canon Norman [2], the distribution of this species is mesoplanktonic, mostly northern, but also in the Bay of Biscay (960 metres). It reaches to about 80° N.[3]

Schizopoda.

The Schizopoda captured belong exclusively to the Euphausiacea, and are referable to only three species. Several forms which might have been reasonably expected among the captures were absent. A list of the British species with their distribution is given by Canon Norman, in his paper on British Lophogastridæ and Euphausiidæ [4].

Thysanoessa longicaudata Kröyer.

A considerable number of specimens of this species were captured: it appeared to be the commonest Schizopod of the Faeroe Channel at the time. The synonymy appears to be *Thysanopoda longicaudata* Kröyer = *Thysanoessa tenera* Sars = *Thysanoessa longicaudata* of Hansen, Norman, Ortmann, &c.

The species ranges from the West Coast of Norway right across to Greenland and into the Labrador current; the 'National' [5] ceased to take it (after almost daily captures up to that moment) from the date of entering the warm water of the Gulf-Stream ('Florida-strom'). Sars [6], who described the species from deep water in the Varanger Fjord, records it also as from the surface at four stations between Norway and Jan Mayen on the cruise of the 'Vöringen' [7]. It appears, therefore, to be essentially a cold-water species, an Arctic type-form, and was captured by the 'Fram' [8].

It has, however, been recorded twice from British coasts [9].

[1] Vosseler: Amphipoden der Plankton-Expedition, p. 86.
[2] A. M. Norman: Ann. Mag. N. H. (7) v. p. 135.
[3] F. Nansen, *op. cit.* p. 19.
[4] A. M. Norman: Ann. Mag. Nat. Hist. (6) ix. p. 454.
[5] A. Ortmann: 'Decapoden und Schizopoden der Plankton-Expedition,' p. 14.
[6] G. O. Sars: Forhandlinger Videnskabs-Selskabet (Christiania), 1882, no. 18, p. 53.
[7] G. O. Sars: Norwegian North Atlantic Expedition (Crustacea), pt. ii. p. 13.
[8] F. Nansen: Norwegian North Polar Expedition. G. O. Sars: Crustacea, p. 14.
[9] A. M. Norman: Ann. Mag. Nat. Hist. (6) ix. p. 463; and the papers there cited.

Once it occurred in enormous quantity in St. Andrew's Bay in company with *Nyctiphanes norvegica*, once at Redcar with a similar swarm of *Euthemisto compressa*, the latter being also an Arctic type-form [1]. In both these cases it is probable that the creatures had been driven down the North Sea by a strong southerly current, in the manner which I have already suggested [2] for *Parathemisto oblivia*; and it has therefore no more right to be regarded as a "British" species than an occasional *Velella* or *Ianthina* brought up by the North Atlantic Drift to our shores. According to Ortmann (*op. cit.*), the 'National' hauls gave no indication of the vertical distribution of this species.

It will appear from the table (p. 119) that the 'Research' was more fortunate, and the hauls point to its having a distinct preference for the mesoplankton in the Faeroe Channel. Like (at any rate some) other mesoplanktonic species, it rises to the surface at night. Specimens with adult characters were captured in 19 per cent. of epiplankton hauls, but in 66 per cent. of mesoplankton hauls. On the other hand, larval and post-larval stages, apparently referable to this species, were obtained in 38 per cent. of epiplankton hauls, but only in one mesoplankton haul, and that one terminating near the 100 fathoms. The species, therefore, appears to be epiplanktonic when young, mesoplanktonic when adult, so far as these observations go and in the Faeroe Channel at this time of year. In seeking deeper (colder) water in this locality, it follows what appears to be the practice of other Arctic type-forms when they meet the warmer water of the North Atlantic Drift. That this was not apparent from the results of the 'National' is probably due to the fact that from the Hebrides almost up to the moment of coming into the Gulf-Stream the vessel was in far colder surface-water than that of the Faeroe Channel in summer.

The larvæ mentioned above ranged from an early *Calyptopis* stage up to the adult condition. It was not, of course, possible to derive them all with certainty from *Thysanoessa longicaudata*; but the majority may be safely referred to this species, not only because the adults captured were far in excess of any other Euphausid, but also because the larvæ could be traced gradually through successive stages back to the *Calyptopis*. The metamorphoses of this species follow the lines indicated by Sars [3] for *Nyctiphanes*, *Euphausia*, and *Thysanopoda*.

As Paul Mayer [4] has shown, the spination of the telson of Malacostracan larvæ yields a character important both for phylogeny and for diagnosis. It has not as yet, I think, been pointed out that the condition of the telson in Euphausiidæ affords a further argument for the view maintained by Boas [5] and others,

[1] C. Chun: 'Beziehungen zwischen dem arktischen und antarktischen Plankton,' Stuttgart, 1897, 8vo, p. 30.
[2] Proc. Zool. Soc. 1898, p. 583.
[3] G. O. Sars: Chall. Rep. Zool. xiii. (Schizopoda).
[4] P. Mayer: Jenaische Zeitschrift, xi. (1877), p. 246 *et seqq.*
[5] J. E. V. Boas: Morphologisches Jahrbuch, viii. p. 485.

that this family takes its origin very near to the root of the Decapodan stem, and that it has far closer affinities with the latter than with the Mysidæ. In *Nyctiphanes*[1] and *Euphausia*[2], and possibly in other genera also, the youngest *Calyptopis*-larvæ show seven spines on each side of the telson; unlike all other Schizopoda, so far as is known, except perhaps *Lophogaster*, they are thus in absolute accord with the "ursprüngliche Borstenzahl 7+7" which Mayer attributes to the primitive Macruran and Brachyuran. In *Euphausia*, *Nyctiphanes*, *Thysanopoda*, and *Nematoscelis* according to Sars (*op. cit.*), and in *Thysanoessa*, the number is increased at later stages by a median terminal spine, which, like the others, is jointed to the telson. Accepting Mayer's enumeration of the spines from the middle line outwards, and styling the median azygos spine of the Euphausiidæ as 0,—spines 7 are found in the adult *Thysanoessa* about one-third of the length of the telson from the root; spines 6 at about two-thirds of its length from the root; spines 5 are lost; spines 4 persist as the large lateral jointed spines near the end of the adult telson[3]; and spines 3, 2, 1, 0 disappear altogether in the course of development. On page 131, I have illustrated four stages in this reduction omitted by Sars, of which fig. 15 does not quite bear out his description: these show the disappearance of the median spine 0, and the commencement of a new *unjointed* growth of the telson backwards, to form the lanceolate tip of the adult. The character of the telson and the presence of this median spine will apparently form a good criterion for the separation of Euphausidan larvæ (at stages later than the Metanauplius) from other Schizopodan and from Decapodan larvæ.

The earliest *Calyptopis*-larvæ captured by the 'Research' resembled closely those figured by Sars (*op. cit.*) for other genera, except for the facts that the carapace was much more globular anteriorly and was devoid of spines or processes.

Nyctiphanes norvegica M. Sars.

This form was captured on only six occasions. Although a North Atlantic type, it is not an essentially Arctic type like *Thysanoessa longicaudata*: it is of constant occurrence in certain localities on our own coasts, and has been recorded from as far south as Portugal. The various records of its occurrence are cited by Canon Norman[4], but unfortunately the size of the individuals and the depth from which they were derived are only rarely noted. I am informed by Sir John Murray that, in his experience, large adult specimens are taken only in deep water.

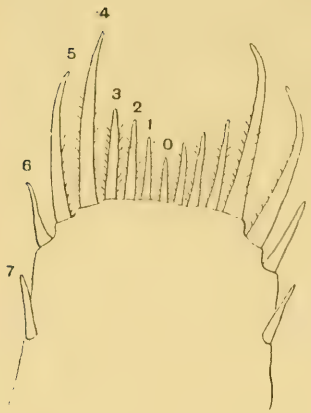
[1] G. O. Sars: Chall. Rep. Zool., xiii. Schizopoda, pl. xxvii. fig. 6.

[2] C. Claus: Untersuch. Crustaceen-Systems, pl. i. fig. 2, Wien, 1876, 4to.

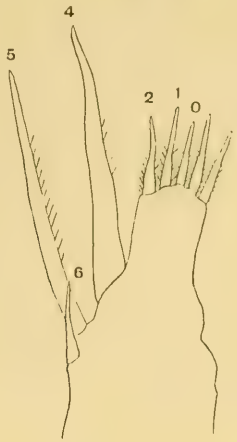
[3] With regard to these, Boas (*op. cit.* p. 523, note 5) has suggested that they may be homologous with the long caudal appendages of *Nebalia* and many Phyllopods. This possibility is rendered considerably more remote by their being merely two persistent spines out of a series which is not represented in the forms cited by him.

[4] A. M. Norman: Ann. Mag. Nat. Hist. (6) ix. pp. 459–460 (1892).

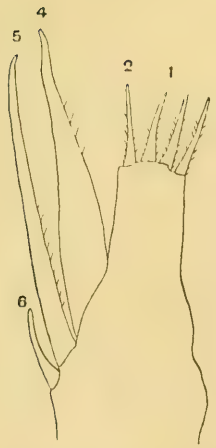
Text-fig. 13.



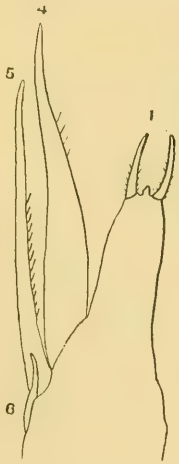
Text-fig. 14.



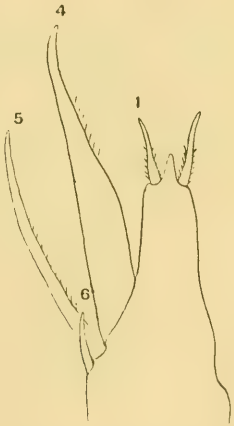
Text-fig 15.



Text-fig. 16.



Text-fig. 17.



Telsons of larvæ attributed to *Thysanoessa longicaudata*, showing reduction of the primitive seven pairs of spines and formation of the median unjointed spine of the telson.

Fig. 13. Early *Calyptopis*, 1·5 mm. long.
14. *Furcilia*, 4·5 mm. long.
15. *Cyrtopia*, 5 mm. long.
16. Late *Cyrtopia*, 5 mm. long.
17. 4 mm. long.

The same distribution was noted by Vallentin and Cunningham[1]:—"The adult, so far as our information allows of a decision, lives on the bottom, and never swims far from the ground [90–95 fathoms in this instance], while the young, up to half or three-quarters the size of the adult, occur abundantly at the very surface and at all intermediate depths. As mentioned above, Mr. Murray found swarms of individuals at the surface in the Faröe Channel, but none of these were full-grown, and very few more than half the adult size."

I have no doubt that this generalization will prove true for greater depths: I took adult specimens, over 35 mm. in length, only between 350–220 fathoms, 400–300 fathoms, 500–400 fathoms: the remaining specimens varied from 9 to 17 mm. in length. In other words, *Nyctiphanes norvegica* is apparently mesoplanktonic when adult.

A few larvæ, larger for their stage of development than those attributed to *Thysanoessa*, were taken at the surface, and may perhaps belong to *Nyctiphanes*: they have not been included in the tables.

Thysanopoda microphthalma Ortmann. (? = *Thysanopoda microphthalma* G. O. Sars.)

Three specimens, recognizable as young forms by the character of the second maxilla and gills, and by the spination of the telson, of about eight, twelve, and fourteen mm. in length, appear to be referable to the same species as specimens recorded in quantity by the 'National' in 60° 3′ N., 27° 0′ W., at a probable depth of between 218 and 328 fathoms. These were referred by Ortmann[2] to *Thysanopoda microphthalma* of Sars[3], a species founded on two specimens from the *surface* at 26° 21′ N., 33° 37′ W., and 7° N., 23° W. respectively. The identity of the 'National' specimens with those described by Sars seems to me rather doubtful: firstly, because it is not very likely that a rare form such as this should occur as adult both at the surface near the Equator and also at 218–328 fathoms in the Greenland Sea, or at 500–400 fathoms in the yet colder water of the Faeroe Channel; secondly, because Ortmann himself indicates some points of difference between his specimens and those of Sars. My own specimens agree with Ortmann's figure, and differ from Sars's description, in the shape of the antennal scale, and in the absence of a spine from the second joint of the first antenna. The telson was not hispid, probably owing to immaturity; the eye was somewhat flatter than in Ortmann's figure, and showed slight signs of a constriction such as is characteristic of *Thysanoessa*. The matter cannot be settled in default of further specimens, owing to the fact that Sars gave only a woodcut of the entire animal, and no figures of the detailed anatomy.

[1] R. Vallentin & J. T. Cunningham: Quart. Journ. Micr. Sci. xxviii. pp. 325–6.
[2] A. Ortmann: 'Decapoden und Schizopoden der Plankton-Expedition,' p. 9.
[3] G. O. Sars: Chall. Rep. Zool., xiii. Schizopoda, p. 106.

Of the three 'Research' specimens of this species, two came from the Mesoplankton, one from a haul of 480 to 0 fathoms: no examples were captured at the surface, unless some of the larvæ attributed to *Thysanoessa* belonged to this species; this is unlikely, because in that case the small size of the eyes would probably have betrayed them.

9. On the Present Condition and Habits of the Elk in Norway. By H. J. Elwes, F.R.S.

[Received January 19, 1903.]

(Text-figures 18–26.)

So little seems to be known by naturalists concerning the actual condition of this remarkable animal, that I think some of the observations I have made during six Septembers, which I have spent entirely in the fascinating sport of Elk-hunting, may be worth recording in the Proceedings of this Society.

My experience has been gained entirely in the provinces of North and South Trondhjem, where the Elk is more numerous than perhaps in any other part of Europe, and where it seems to attain a greater size and vigour, if one may judge by the development of the horns (see text-fig. 18, p. 134) than anywhere else in Scandinavia.

I have also derived much valuable information from Capt. Gerard Ferrand, who was, I think, the first Englishman to hunt regularly in the same districts, and whose experience continued almost without a break for 20 years from 1865. This has been invaluable in confirming, and to some extent modifying, my own observations and what I have been able to learn from the natives of these provinces.

Forty years ago the Elk was a much scarcer animal in Central and Northern Norway than it is now, or rather was ten years ago, since which time it has probably decreased in numbers. At that time it was hunted for its meat alone by the proprietors of the regions where it occurred, and in the large tracts of forest belonging to the Government it was not allowed to be shot until 1880. Up till that time very few foreigners knew what magnificent sport Elk-hunting was, and as the natives preferred the meat of cows to that of bulls, which, after the rutting-season begins, is extremely rank and hard, the bulls increased in numbers and were able to grow to a size and age which they rarely attain now.

The legal season for killing Elk was formerly much longer than it is now, and in North Trondhjem lasted for three months. Then it was cut down to 6 weeks, from the 1st September till the 15th October, and now has been still further reduced to a month or 3 weeks in some provinces, whilst in Sweden only 15 days are allowed during which the animals can legally be killed.

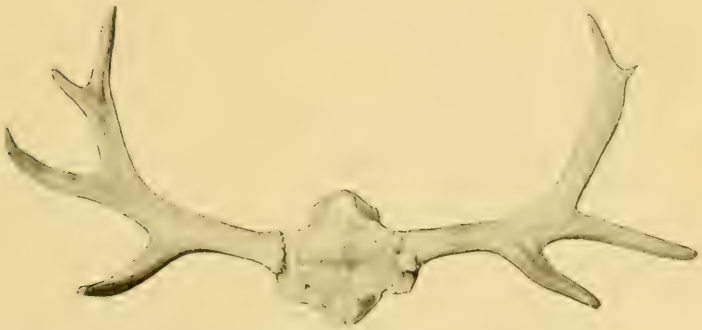
Text-fig. 18.

Horns of fully adult Elk from Trondhjem, Norway, about 64° N.; 54 inches in span, the widest, though not the largest, I have seen from Scandinavia. ($\frac{1}{8}$ nat. size.)

Text-fig. 19.

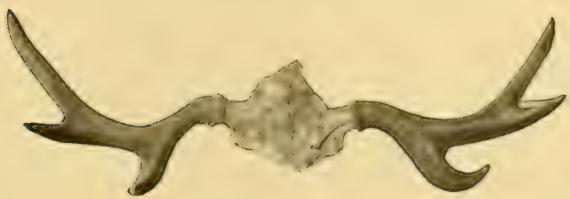
Horns of fully adult Elk killed in Bjorndal, 65° N., Sept. 4 1895; 18 points; a fair average size for this district, but much larger than usually seen in the south. ($\frac{1}{11}$ nat. size.)

Text-fig. 20.



Horns of a full-grown but not adult Elk, killed Sept. 1896 in Upper Namdalen, 65° N. Supposed by natives to be 4 or 5 years old. Probably this type would develop into such antlers as shown in text-fig. 18 if conditions were favourable. ($\frac{1}{11}$ nat. size.)

Text-fig. 21.



Horns of young Elk, supposed to be 3 years old. These would probably develop into such a head as that shown in text-fig. 19. ($\frac{1}{11}$ nat. size.)

This rapid increase of an animal which, on account of its great size and conspicuous tracks, cannot escape unnoticed in an inhabited country, must be entirely attributed to the wise game-laws made by the Norwegian Government, and in most parts honestly observed by the most law-abiding and well-governed people I have ever met with. In former times the Elk, in Scandinavia, as in North America, was hunted down in winter on ski (the Norwegian form of snowshoe), and slaughtered for its meat by every peasant farmer, till it had almost been exterminated. When, however, a law was made that it could be hunted only in the month of September, which period was for a time somewhat extended in North Trondhjem, its numbers soon increased, and about 20 years ago attained such proportions that English and German sportsmen began to visit Norway to hunt Elk. The landowners in some districts then discovered that, instead of hunting themselves or paying Swedish hunters, who, from long experience, were more expert, to kill their Elk for them, the right of killing Elk, which is limited to one animal on each farm, had a letting value; and when many such rights are united so that a large tract of country can be reserved to the lessee, this value was worth a little trouble to maintain. The consequence has been that, though poaching and killing Elk out of season is not entirely unknown, yet it cannot be carried on extensively; and I have little doubt that the Elk will continue to thrive wherever the country is suitable.

The statistics which I append show the numbers of bull and cow Elk which are known to have been legally killed in the various "Amts" or provinces of Norway in 1894, and the average for the previous five years, and may be taken as very nearly exact, though, according to some, the returns for the southern provinces are not so accurate as for the northern ones, and this record takes no account of those illegally killed. It will be seen that only four provinces of Norway (excluding Finmark), namely, Stavanger, North and South Bergenhus, and Romsdal, all of which are on the south-west coast and exposed to the warm and wet influence of the Gulf-Stream, are without Elk; and it may be added that in those four provinces wild Reindeer are most numerous.

North Trondhjem is before all the rest in numbers; and in this province I believe the size of the horns is or was also much larger on the average than in any of the southern districts (text-fig. 18, p. 134).

It is said that the Elk is gradually extending its range northwards, and has appeared in the southern parts of the province of Nordland only in the last few years; and there seems to be no reason why it should not go still further, as in North America the Moose (which is so nearly allied to the Elk, that I do not think it can be looked on as more than a variety of that animal) is found in regions where the climate and food is certainly not more favourable to its habits than they seem to be in some parts of Nordland and Finmarken.

The greater part of North Trondhjem and a large proportion of

South Trondhjem are mountainous, barren, and thinly populated except on the coast and in some inland valleys and fiords, and are covered with forests of birch, spruce, and Scotch fir up to an elevation of about 2000 feet, wherever the ground is not too rocky or swampy for these trees to grow. Above that elevation there are fjelds or bare mountainous uplands, the lower slopes and sheltered dells in which are more or less clothed with birch, willow, mountain-ash, and alder, mixed with stunted firs. There are many large lakes and large areas of peat-bog; but these bogs are rarely so deep and soft as to be impassable, and even after long periods of rain a man can cross them by picking his way.

The country is divided into so-called farms, most of which consist of small patches of oats and potatoes, with from 10 to 30 acres of meadow-land which is mown for hay, and the produce of which is eked out by small ricks which are put up wherever a sledge-load of grass can be got together in the forest. A large area of forest and mountain is attached to each farm, and there are usually one or two sæters[1] on the mountain, to which the cows are driven for about three months in summer. Though most of these farms belong to the occupiers there are some large private properties, belonging to timber companies and public institutions, and much of the higher fjeld and barren mountain remains in the hands of the Government.

In the wilder and less populated districts the Elk are hardly disturbed during eleven months of the year except by the occasional attacks of bears and wolves. Though the bear has become rarer of late years, the wolf, on the contrary, has appeared in districts where it was until recently almost unknown; but at present they have confined their attacks rather to the semi-wild reindeer, which are kept in some numbers by the Lapps all along the Swedish frontier, from Roros northward, and to the sheep, of which every farmer has from 10 to 30. It seems to be doubtful whether bears can kill full-grown bull Elk[2], but during my last hunting-season I found the remains of no less than three Elk calves which had been killed by them.

The favourite food of the Elk in summer consists almost entirely of the twigs and leaves of birch, willow, and mountain-ash, and in winter of the branches and bark of the same shrubs. Wherever there is a grove of mountain-ash, Elk will live almost entirely on it so long as they can get it, and in districts where Elk are abundant the tree is constantly eaten down, so that it seems likely to become much scarcer than at present.

Scotch-fir twigs are also largely consumed during the winter, but do not seem to be eaten so long as mountain-ash can be easily procured. Though I have never actually seen Elk eating grass, I am assured by the native hunters and by Capt. Ferrand that they do so in summer to some extent, and also bite off the flower-heads of *Epilobium* and other plants. Water-lily roots,

[1] "Sæter" is the Norsk term for a shieling.

[2] Capt. Ferrand has known a bull Elk beat off the attack of two bears in company.

which are said to be the favourite summer food of the Moose in America, are also eaten, though the plant is rare in the districts where I have hunted.

The Elk seems to spend the greater part of the day in feeding, though it lies down for some hours to chew the cud. Some hunters say that it has a regular time for lying down, and will not hunt between 11 and 2 o'clock, because of the great difficulty of approaching the animal when it is resting. I have, however, seen them lying at all hours between 9 A.M. and 3 P.M., and have found them up and feeding at midday and later, so that there is evidently no rule beyond the appetite of the individual animal.

From its great size and the nature of its food, the Elk requires a much larger extent of feeding-ground than any animal I am acquainted with, except the elephant; and I should suppose that at least three square miles of suitable forest would not support more than one Elk continuously, judging from the number I have found in places where they were at home and undisturbed.

It is an animal of extremely solitary habits, and in summer more than three will hardly ever be found together, and more often only two. A family-party usually consists of a cow, a calf, and a yearling; very often the cow and the calf are alone, and two bulls are frequently found together before the rutting-season begins. In winter, however, they are said to be somewhat more gregarious, but I have never heard of more than nine actually being seen in company in the autumn.

In some Swedish forests, which are strictly preserved for shooting, it is said, however, that the Elk associates in larger herds, and has become so numerous that much damage is done to the forest by their biting off the shoots and tops of the young Scotch pines; but in such localities they do not attain the size and vigour that they do where they have a wider range and a greater choice of food, as in the two provinces where I have observed them.

The Elk is commonly supposed to be essentially an inhabitant of forests, and though this is to some extent the case, and in winter it no doubt almost invariably keeps to the shelter of the forest, yet I have lately become convinced that it is found on the higher fjelds to a much greater extent than is generally known. As high as the birch is found, Elk may certainly be seen in summer; and the old solitary bulls in districts where open fjelds exist rarely descend into the pine-forest until the rutting-season begins. From 1500 to 2500 feet is a very common range in summer, and on the high mountains of Upper Tydal I have seen tracks much higher than this, far out in the open fjeld on the Swedish frontier. And in North Trondhjem, where the timber-line is not so high, the open hill-tops in some places are covered with Elk tracks and dung, as though the animals had remained there during the whole of the hot weather. Capt. Ferrand assures me that he has killed a bull on the mountain above Lake Fæmen at an elevation of at least 3700 feet, on regular reindeer-ground, where arctic willows were

the only shrubby plants. When found in such situations, they may be stalked in exactly the same way as red deer, but when disturbed usually make for the shelter of the forest; and even on the fjeld they nearly always lie in or close to a small grove of dwarf birch, and are in consequence not so easy to find with the telescope as red deer.

The Elk is supposed to be monogamous, and I have never seen more than one cow in company with a bull during the rutting-season; but I am assured by a Lapp, whose knowledge of their habits is very great, that in districts where cows are more numerous than bulls, the older bulls will change their mates two or three times during the season. This seems to be confirmed by the fact, which I have often noticed, that at the end of September, when the rutting-season is approaching its height, cows are often found without bulls, and the tracks of solitary bulls are found, travelling presumably in search of fresh cows.

Col. Walker, of Tykillen, Co. Wexford, who has had great experience in Elk-hunting, relates the following event in a letter to me:—

"Thomas and I saw a magnificent bull with a splendid head in company with a cow and calf; they were quite in the open on the edge of a small lake about half a mile from us.

"I noticed that whenever the bull went to the cow she ran at him, and butted him very hard in the ribs; he then each time ran from her, and browsed on the trees. Thomas then told me that it would be useless to stalk this bull as he would be gone in a few minutes. His story was that the bull only remains with the cow for three days, and then she beats him off, and he has to go and find another. Thomas had hardly done telling me this when the bull made his last appeal to the cow. She gave him a rough reception, and he at once started off at a fast trot. She remained grazing, and we could see the bull going away very fast for nearly two miles over a long stretch of open mountain, which took him across our boundary. We never saw this bull again."

Another proof of their polygamous habit is that on such ground as that on which I hunted last year, where during eight years only one cow has been killed for every five or six bulls, and where in consequence the cows were far more numerous, I found no more barren cows than in districts hunted by Norwegians only, where more cows than bulls had been killed.

A point upon which I have never been able to get any certain information in Norway is whether the sexes attract each other by calling at night, as the American Moose do. The art of calling is unknown to Scandinavian hunters so far as I can learn, though it is said to be practised in North Russia and Kurland. The weather in Norway is usually so wet and stormy at the end of September that there is no inducement to lie out in the forest; and though I have spent many nights in remotely situated huts and sæters, and have listened at dark and daylight, I have never heard such a call as is made by the Moose. The cows do, however, call to their calves, and I have heard bulls uttering a low grunting

noise when alone, and apparently looking for cows. On this point, however, I quote Capt. Ferrand's experience, which is that he has on several occasions attracted bulls whose whereabouts he knew, especially on a still frosty evening, by imitating the grunting of the bull, which can be heard when they are looking for cows at a distance of from 500 to 1000 yards, or possibly more. Moreover, he has heard the cows make a somewhat similar noise, and the calves make a bleating noise when they have lost their dam.

Col. Walker also writes to me on the subject of the cow calling for the bull, as observed by him at Storvand, on the property of Mr. Collett near Mo, in North Trondhjem, in 1890:—

"One day my hunter and I came on the spor of a bull Elk and cow; after some time we looked over a small hill and saw, in the valley below it, the bull and cow about 150 yards from us. Seeing that he was paying her great attention I waited to see what would happen; after one or two attempts he jumped on her, they having their backs to me: I aimed at him, but waited until he had finished his performance; as he came off her I fired, and shot him stone dead. He rolled off on to the ground. She did not appear to have noticed the shot or that he was dead, but began to graze close to him, and once or twice went over and smelt him, then grazed again. I then walked up to the bull; she did not seem to mind me, only stared at me and stood close to the bull. When I was within twenty yards of her she got alarmed and went off, very slowly at first, constantly looking round for him to follow her. Shortly afterwards, while we were cutting up the bull, we heard a very loud harsh roaring noise, just like the noise made by a badly wounded bear when pinned in a corner. Both my hunter and I thought it was a bear. I then went to the top of a small hill, and on looking over saw the cow in the middle of a large open bog. She was roaring, I could see her quite plainly through my glasses; she then got wind of me and bolted off.

"On another occasion I had killed a bull which was in company with a cow and two calves; these bolted, the cow one way, calves the other. About 7.30 P.M., when I was in my hut, I heard a cow calling just like a domestic animal in this country. I asked Thomas whether we were near a farm; he then told me it was the Elk cow calling for her calves."

Though the scent and hearing of the Elk are unusually acute, their sight seems to be by no means so quick as that of deer: if it were, the difficulty of shooting them, which is already very great, would be much increased. The usual method adopted in Norway is to use a trained dog in a leash, which can scent the Elk at a distance of a mile or more in the forest; but owing to the difficulty of approaching without noise in the thick forest, and the cunning which the Elk almost invariably display in lying down so as to get the wind of anyone following their tracks, only those who have great patience, caution, perseverance, and an intimate knowledge of the habits of the Elk and the ground, are successful in

getting more than a glimpse of a frightened Elk disappearing among the trees. But if you can succeed in seeing the Elk before he has heard or smelt you, you may take liberties with his eyesight which would not be possible in deerstalking. I once approached a cow Elk, which was lying with her calf on an open hillside, within 10 yards by keeping her body between me and her head, and might have got nearer if the calf had not seen me. On another occasion I rowed in a boat, just as it was getting daylight, within 150 yards of a bull Elk, which had been lying on the shore of a lake, and had not yet got up from his lair, and shot him from the boat before he had taken alarm.

When bulls are rutting they sometimes run towards a man whom they have heard but not seen, thinking that it is another Elk, and in consequence stories are told of their attacking human beings. But these stories will rarely bear investigation, and though there are undoubted instances of wounded Elk attacking human beings, I never but once saw one turn upon me, and then only because he could not get away.

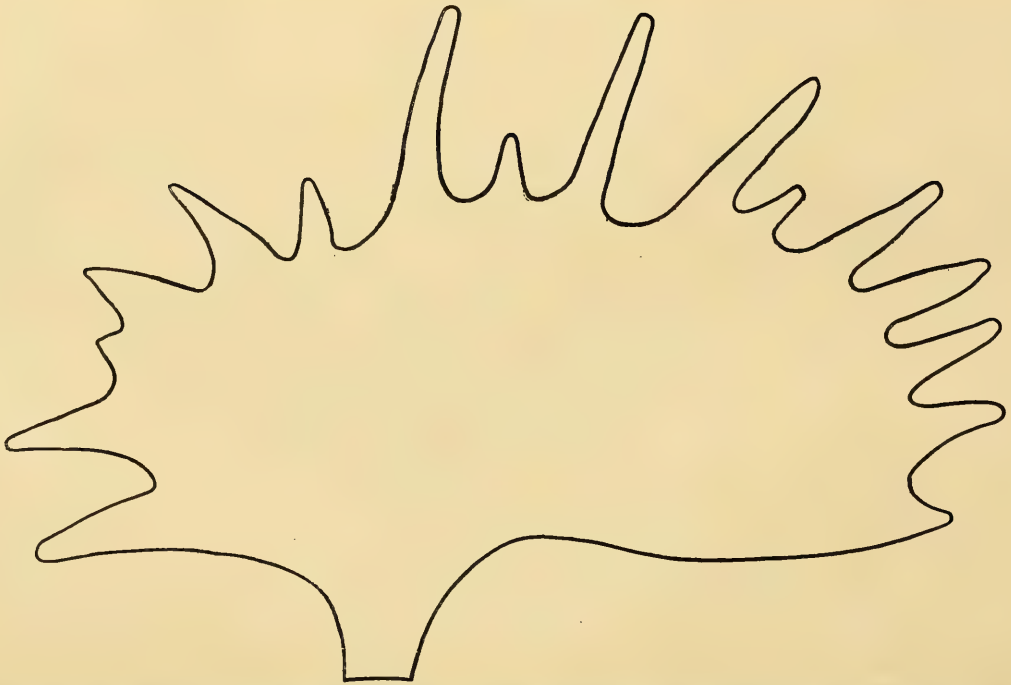
Besides the system of hunting them with a dog in a leash, they are also hunted to some extent with loose dogs which bring them to bay; and though this system requires a man of great endurance in order to follow fast enough to keep the hounds within hearing, sometimes for many hours, it is perhaps more exciting and deadly than still hunting. When Elk are so disturbed by dogs and have not seen, heard, or smelt man, they will sometimes come to bay very soon, but more often run many miles, and always try to throw the hounds and hunter out by crossing large rivers or lakes. The Elk is an extremely strong and good swimmer, and quite at home in the water, and though he usually crosses a large river where it is shallow, he can, when pressed, pass a roaring torrent, where no boat could live. In the very wet autumn of 1893 I lost several of the bulls I hunted, in consequence of their crossing rivers which we could neither ford nor swim; when severely wounded an Elk usually takes to water.

They may sometimes be driven successfully in places where the ground is very steep or confined, but as a rule Elk do not follow particular paths so much as most large animals, and can go up and down very steep ravines and rocky places which would be thought impossible for so large and heavy an animal. They usually feed up wind and run down wind, but there is no rule about this, and after a long hunt they sometimes come back nearly to the same ground they started from.

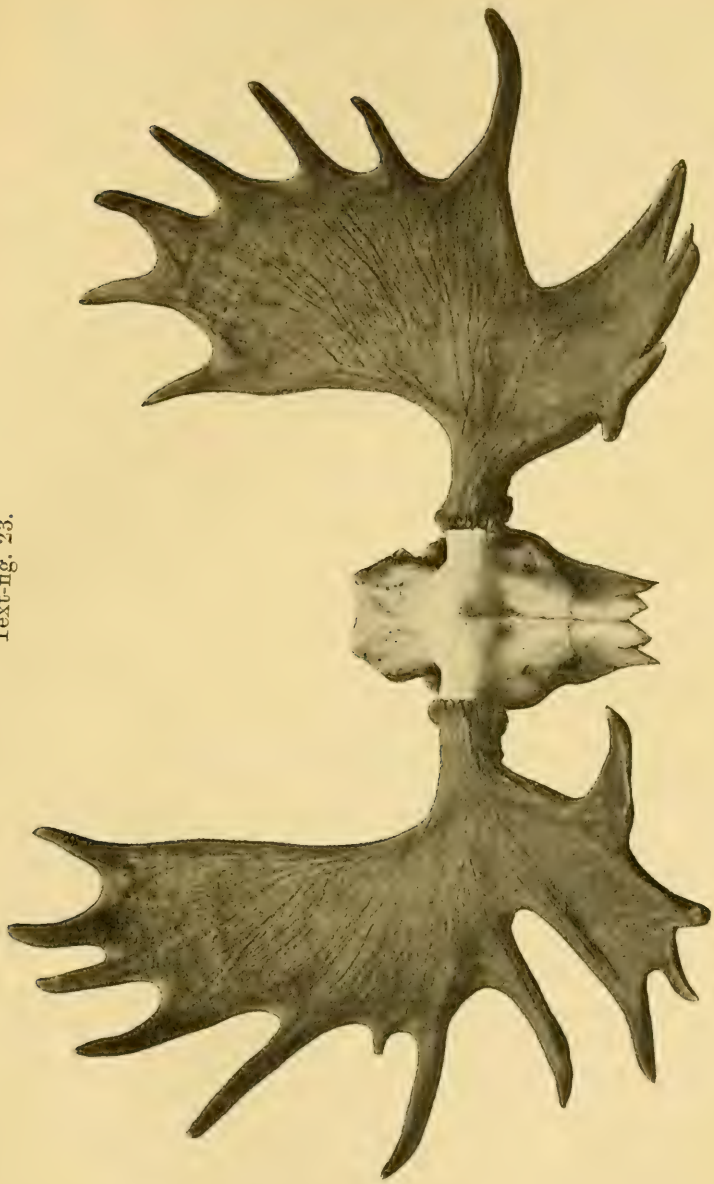
On the whole, I consider Elk among the most difficult animals to hunt that I have ever had experience of, and, even where they are quite numerous, I have more than once spent ten days without getting a fair chance at an animal worth shooting.

The bulls are said by some to shed their horns as early as Christmas and not later than January, as Mr. Meade-Waldo tells me they have done in our Gardens. Capt. Ferrand, however, has been informed by woodcutters who were working all winter

Text-fig. 22.



Tracing of shed horn picked up at Mo, and now in the house of Mr. Collett, occupied by Sir H. Pottinger. The largest horn I have ever seen in Scandinavia.—I killed a bull, which was supposed to have carried this horn, in the district some years afterwards, but his horns from age had much degenerated. ($\frac{1}{7}$ nat. size.)



Text-fig. 23.

Horns of a large Elk from Lithuania, in Branicki Museum.

in the forest, that March is a more usual time, and this seems more probable having regard to the time at which the horns of other deer are shed. The new ones begin to grow in April or May, and are fully developed about the middle of August. In September the velvet is rubbed off against a young fir-tree, which is usually destroyed in the process, and from the middle to the end of September the rutting-season commences. At this season the bulls have a very strong, rank, musky smell, and scrape shallow round holes in the ground like stags' wallows, which retain the scent of their urine for some days. Occasionally the bulls fight desperately, and I have seen places where the ground was torn up over many yards and sprinkled with hair and blood, but few hunters have had the good fortune to witness such an encounter.

The development of the horns of the Elk in the Namsos district of Norway is apparently greater than in South Norway and Sweden, or in the districts which it still inhabits in East Prussia and Kurland, though I cannot speak with the same certainty as to Russia.

On my return from Siberia, four years ago, I saw semifossil horns of the Elk from the district of Perm, which were larger than any I have seen in Europe; but on visiting the best collections I could hear of in St. Petersburg, I saw none which appeared to me better than the best Norwegian heads, or so good as the one figured (text-fig. 23, p. 143), which is that of a Lithuanian Elk in the Branicki Museum at Warsaw.

The bull calf has no horns the first year. The second year he has a small spike on each side, sometimes, but rarely, two spikes, and I have seen one on one side and two on the other. As he grows older it is supposed that the number of points increase annually, one on each side; but I think this is not at all invariably the case, and that the size and strength of the individual has much more influence than the age, and probably, as in the case of other deer which shed their horns annually, food and climate have a good deal to do with it. As a rule the horns increase in size and number of points up to 10 or 12 years old and possibly more, and in old animals have a tendency to diminish in size and in the length and strength of the points. From 18 to 22 points are perhaps the average of adult males in Northern Norway, and 10 to 14 points in Southern Norway.

The widest span which I have ever seen is 54 inches (text-fig. 18, p. 134), and the greatest number of points 16 on one side, as on the shed horn of which I show a tracing (text-fig. 22, p. 142). The breadth of the palm in this instance and the number of points are quite exceptional, and I very much doubt whether there are any such Elk now alive in Norway, as Herr Bruun of Trondhjem, who has the opportunity of seeing all the finest specimens which are procured, says that he has seen nothing equal to them.

Moose heads of as great or greater size are, however, often killed, and though the largest which I have ever seen is 65 inches

across, I have heard on fairly good authority of one over 6 feet in span. (This was written before anything was known of the gigantic heads found in Alaska.)

With regard to the comparative size and weight of the Elk and Moose, I cannot speak positively, as it has never been possible to weigh an entire animal in the places where I have killed them.

Mr. Abel Chapman, however, gives me the following weights of a bull, of fair but not unusual size, killed by him on Sept. 15th :—

	Kilogrammes.		Kilogrammes.
Head with skin of neck	40	=	40
Shoulders	42 each	=	84
Haunches with feet	54 ,,	=	108
Sides	40 ,,	=	80
Neck and back	60	=	60
Skin, say	30	=	30
	Total		402

This would make the weight of the living animal at least 1000 pounds or over, as the intestines are enormous.

Capt. Ferrand's best bull, a 10-year old, weighed 1240 English pounds without the intestines.

The pace of Elk, when undisturbed, is a slow walk, and their movements are very deliberate, but they can trot for many miles over boggy and rough ground at a pace of 6 or 8 miles an hour, and occasionally when much frightened break into a lumbering canter.

The female Elk has her first calf at three years old in the month of May, which makes the period of gestation about 7 months. Usually she has only one, but not unfrequently two calves, which grow very rapidly, and by the end of September are as big as a red-deer hind. They suck their dams until late in the winter, and keep company with them until another calf is dropped, and sometimes longer. They have occasionally been tamed in Sweden and taught to go in harness, but owing to the difficulty of feeding them they are not easy to keep in confinement. I have seen, however, in the Zoological Gardens at Rotterdam a cow Moose which is said to have been about 20 years in confinement, and I hope that we shall be equally successful with the one which was captured by Mr. Nickalls and presented by him to our Gardens.

Statistics of the number of Elk killed in Norway in the season of 1894. (Translated from the 'Tidsskrift Norsk. Jæger og Fisker Forenings,' Heft 3, 1895.)

Name of Amt.	No. of Bulls.	No. of Cows.	Total.
Smaalenene	8	3	11
Akershus	67	60	127
Hedemarken	74	72	146
Kristians	90	87	177

Name of Amt.	No. of Bulls.	No. of Cows.	Total.
Buskerud	69	73	142
Jarlsberg og Larvik	9	8	17
Bratsberg	54	48	102
Nedenes	3	7	10
Lister og Mandal	1	—	1
Sondre Trondhjems	50	50	100
Nordre Trondhjems	212	194	406
Nordland	9	4	13
Stavanger	—	—	—
Sondre Bergenhus	—	—	—
Nordre Bergenhus	—	—	—
Romsdal	—	—	—
Finmarken	—	—	—
	646	606	1252
Average for the 5 years, 1889–93.	610	512·6	1122·6

To give a better idea of the numbers of Elk found in what was perhaps, at that time, the best forest in Norway, I give the following statement copied from my diary in 1895. The number actually seen may possibly represent from $\frac{1}{2}$ to $\frac{1}{3}$ of the number actually on the ground at the time:—

		Bulls.	Cows & yearlings.	Calves.	
Sept. 2.	Haende	...	1	...	Barren cow shot for meat.
3.	Storen	...	1	1	
4.	Strommen	...	1	1	
5.	Strommen	1	1 1	...	1 bull killed: 18 points.
6.	Blank day.				
8.	Mo	1	1	1	
9.	Mo	...	1	...	
10.	Oplo	...	1	1	
11.	Synnæs	...	1	...	
12.	Lia	1 1 1	1	...	
13.	Lia	1 1	...	...	1 bull killed: 16 points.
15.	Blank day.				
16.	Mo	1	1	1	
17.	Storengen	...	1 1	...	
18.	Storengen	1	1	1	
19.	Fos	...	1	1	
20.	Mo	...	1 1	1	
21.	To Storvand, blank day.				
22.	Vennevik	1	1 1	1	1 bull killed: 6 points.
23.	Synnæs	1 1	1 1 1	1 1	
24.	Brotten	1 1	...	...	1 bull killed: 14 points.
25.	Synnæs	1	1	1	1 bull killed: 13 points.
26.	Quisten	1	...	...	1 bull killed: 11 points.
27.	Oplo	...	1	1	
29.	Mo	1	1	1	1 bull killed: 18 points.
	Total	17	25	14	

This number of Elk was found on about 12 farms out of 24 over which I had the right of hunting. These farms might average 10,000 acres more or less in extent.

On the same ground as this Col. Walker kept the following record of the Elk which he saw himself during the four seasons 1887–1890, between Sept. 1st and Oct. 10th. It tends to show

how rapidly Elk increase where they are protected and the cows not killed :—

Year.	Old Bulls.	Young Bulls.	Cows.	Calves.	
1887.	3	—	9	10	Two of these cows had two calves each.
1888.	7	2	8	7	One of these cows had two calves.
1889.	6	6	17	14	Six of these cows had two calves each.
1890.	5	10	18	20	Nine of these cows had two calves each.

Most of these observations were written at the request of our late President, Sir W. Flower, six years ago, but were withheld from publication until this year, when the question of a new species of Elk existing in Siberia was raised by Mr. Lydekker and the Hon. W. Rothschild. I then added the following appendix.

Text-fig. 24.

Horns of a very old Elk showing degeneration. (About $\frac{1}{12}$ nat. size.)

Appendix.—On the Variation of the Elk.

Dr. Lönnberg's paper on the variation of the Elk appears to me to confirm the opinion I expressed at a recent meeting of the Society (P. Z. S. 1902, vol. ii. p. 144), that the Siberian Elk described by Mr. Lydekker (P. Z. S. 1902, vol. i. p. 207) as *Alces bedfordiæ* was nothing more than an inconstant variety of the European Elk. The Hon. Walter Rothschild has since expressed a contrary opinion, for which, however, I am not aware that he has any further evidence than the fact that other horns similar

to those of the so-called *A. bedfordiæ* have been received by him from Siberia. I stated that the only horns of the Elk which I succeeded in obtaining in the Altai Mountains in 1898, which are now in the St. Petersburg Museum, were palmated in precisely the same manner as those of the Norwegian Elk, and others which I have seen in Russian collections had all well-developed palmation. Dr. Lönnberg's figures go to show that the development of the antlers in those parts of Sweden from which they come is nothing like so fine as in the districts of North and South

Text-fig. 25.

Tracing of a cast horn found at Solem in Bangdal by Capt. Ferrand. (About $\frac{1}{11}$ nat. size.)

Trondhjem, where most of my hunting has been done. When I first began Elk-hunting in Tydal, a mountain valley in South Trondhjems-amt running up to the Swedish frontier, I should have considered the horns figured by Lönnberg in fig. 3 as a fair representation of an adult Elk in that district; but I have seen them with as many as eleven points on each horn, and believe that horns with even more points have been obtained. Further north, in North

Trondhjems-amt, where the Elk a few years ago was extremely numerous, much larger heads occurred, owing, I believe, to the much greater quantity of mountain-ash, which seems to be the favourite winter food of the Elk, and which has been to a great extent destroyed by the vast number of animals constantly devouring it.

Out of the whole number of bulls I have killed, about twenty, only four or five had horns of the type shown in Lönnberg's

Text-fig. 26.

One-horned Elk in Ipswich Museum.

figures 1, 4, 6, and 9; and all of these, with one exception, appeared to be quite young animals.

Among the hunters who accompanied me in different years were a Swede, a Norwegian, and a Lapp, all of whom knew the Elk of those districts most intimately, and were considered the most experienced hunters of their districts. None of them ever even suggested the possibility of two races of Elk existing; and I

attribute non-palmation of the horns entirely to imperfect development of the animal, caused by insufficient food in their earlier years, or degeneration caused by old age, wounds, or otherwise. We did not reckon an Elk to be adult until he had at least seven points on each horn, and the oldest and largest bull that I ever killed, which had been well known in the district, and continually hunted for at least ten years, had, when I killed him, well-palmated horns of about one-half the size of what they ought to have been in an adult animal of his size, showing that in the Elk, as in the red deer, the horns degenerate in size and number of points in old age, which may be fifteen or twenty years or less.

Two such instances of degeneration are figured. Text-fig. 24, p. 147, is the head of an old Elk killed by Thomas Bate, Esq., in Lurudal Namdalen on Sept. 25, 1890. The horns measure 43 inches in expanse, with ten points on one side and eleven on the other; the points are, however, not arranged in a uniform series on the edge of the palm, and the development of the brow-antlers is very abnormal.

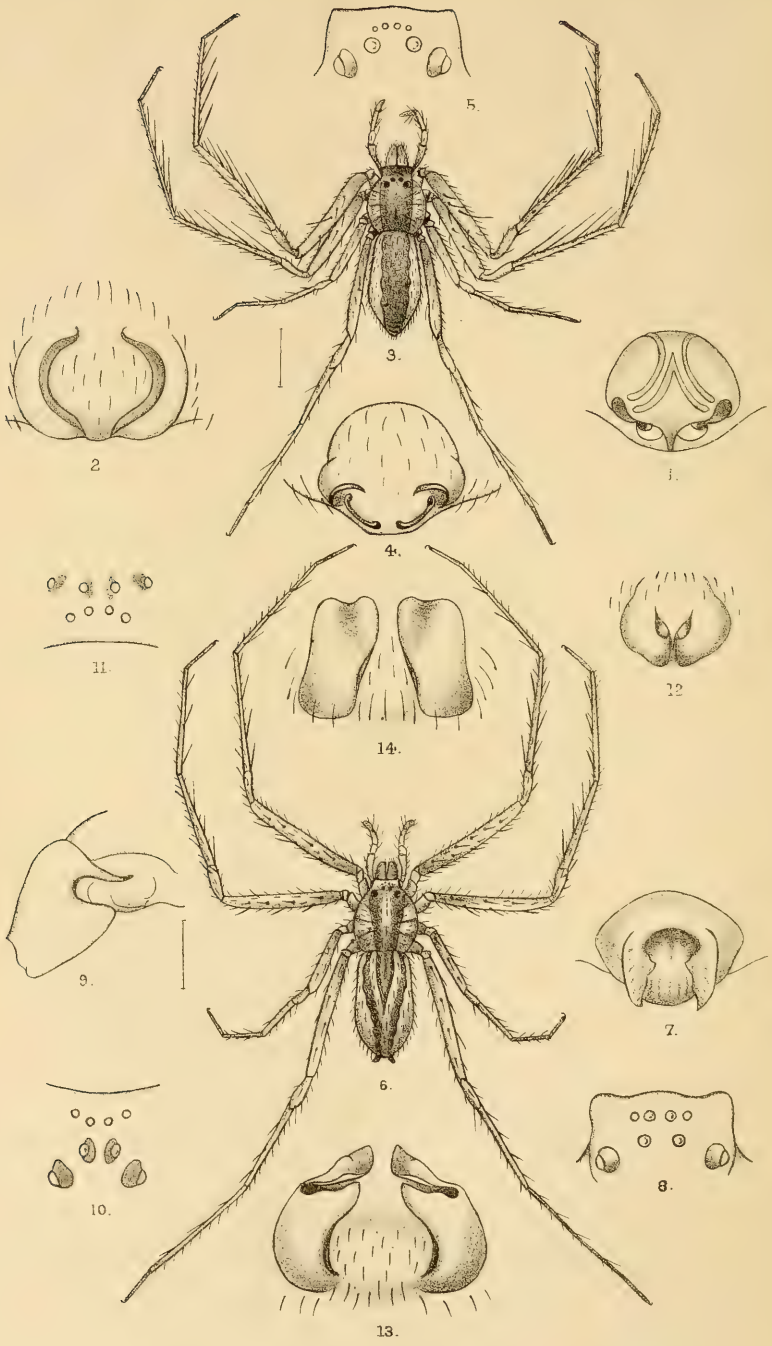
The shed horns of what was probably the same animal were picked up on the same ground in the year previous by Col. Sullivan, and are of the same type with the same number of points.

An Elk displaying still more remarkable abnormal degeneration was killed by Capt. Ferrand, and is shown in text-fig. 26, p. 149.

This animal was supposed to be 25 years old or more, and the incidents of his death have been most graphically described in the 'Badminton Magazine' for March 1901 by Capt. Ferrand. The horns are now in the Ipswich Museum.

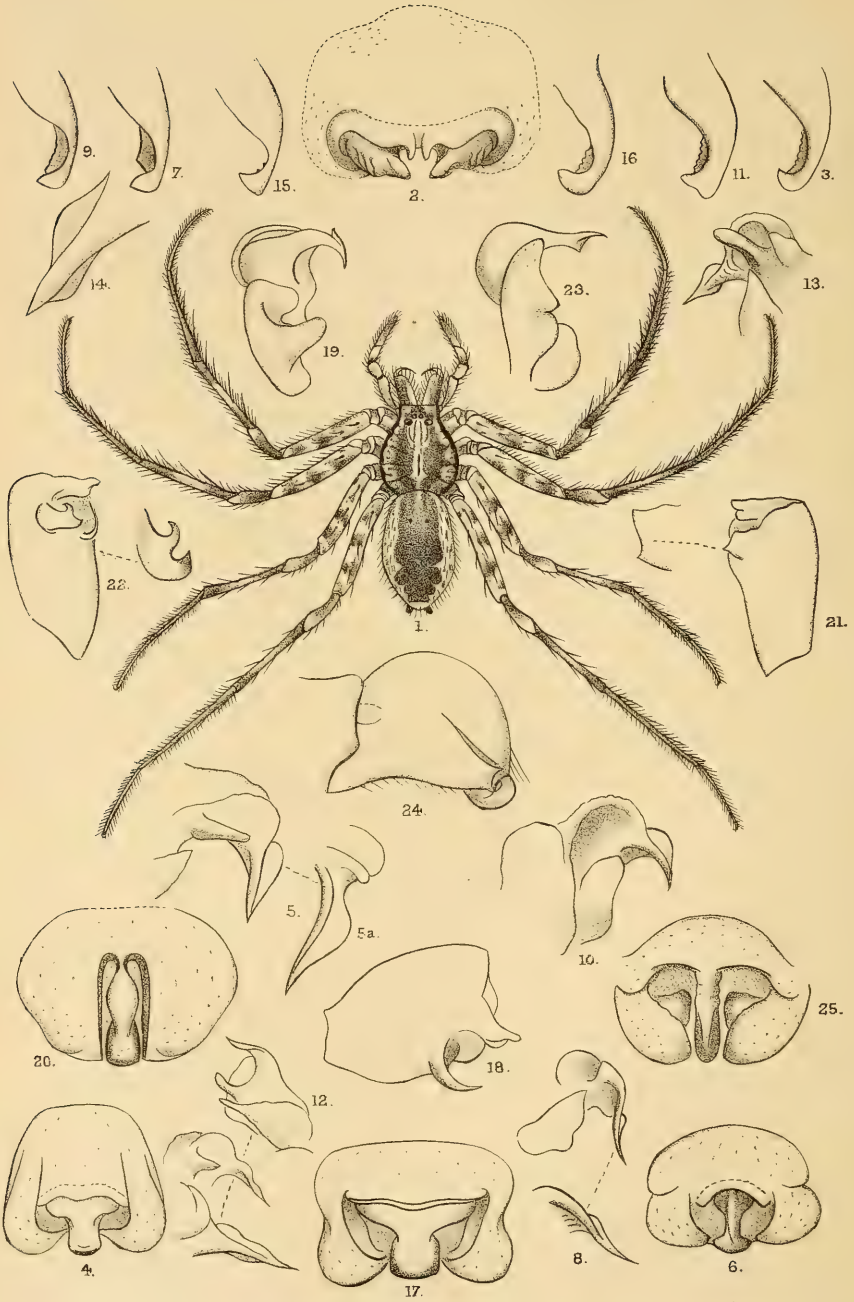
The largest horns I have seen from Norway, belonging to an animal which I unsuccessfully hunted for many days, but which was afterwards killed by a farmer, and sold to me by Mr. Bruun of Trondhjem, were 54 inches in width, with nine points on each side (see text-fig. 18, p. 134); but there is a pair of shed horns in Sir Henry Pottinger's house at Mo, of one of which I send a tracing (see text-fig. 22, p. 142), showing sixteen points on each side. It is well known in Norway that the Elk of the southern districts, which are much more fully timbered, and where there is nothing like the same extent of open fell and good feed as in North and South Trondhjem, and where both sexes are much more constantly hunted and the calves frequently deprived of their mother's milk in September, do not, in modern times at least, produce anything like such fine heads as those of the wilder districts of the north, the conditions being probably very similar to those described by Dr. Lönnberg as in the southern provinces of Sweden[1]. Taking his nine figures, I should be inclined to say that all except 2 and 3 might, if they had come from Siberia, have been considered as belonging to *Alces bedfordiæ*; and form, to my mind, ample proof of that being (if the horns belong to

[1] Mr. Percy Godman informs me that a well-known Elk-hunter in South Norway considers that on his property Elk have diminished by two-thirds in the last ten years, and attributes this decrease to their having eaten and destroyed all the "leaf-trees," *i. e.* willow, mountain-ash, and aspen.



F.Pickard Cambridge del et lith. West, Newman imp.

SPIDERS OF THE FAMILIES PISAURIDÆ AND SENOCULIDÆ.



F. Pickard. Cambridge. del. et lith. West, Newman imp.

SPIDERS OF THE FAMILY PISAURIDÆ.

adult animals) nothing more than a local variety produced by comparatively unfavourable conditions. In considering the probability of the existence of local races of Elk, it must be remembered that no northern mammal, except perhaps the reindeer, has such wandering habits; and though a race might become temporarily isolated in an area which was entirely surrounded by a large extent of country providing no suitable food, yet there is no doubt, in my mind, that when their favourite food had become partially exhausted, they would migrate many hundreds of miles, and thus prevent the establishment of local races.

A very interesting paper on the former existence of the Elk in the Thames Valley in England, with a plate showing the great similarity of its horns to those now existing, is published by Mr. E. T. Newton, F.R.S., in the Quarterly Journal of the Geological Society, vol. lix. (1903), and I am much indebted to that gentleman for sending it to me.

February 17, 1903.

Dr. Henry Woodward, F.R.S., Vice-President, in the Chair.

Mr. R. E. Holding exhibited and made remarks upon an adult skull of a Collie Dog, indicating a displacement of the incisors caused by the closing of the left lower canine upon the third incisor of upper jaw, and which apparently retarded the development of the second incisor of that side. The skull also showed a supernumerary canine which could in no way be mistaken for a retained milk-canine.

Mr. Holding also exhibited portions of three Rabbits' skulls having "over-shot" incisor teeth. In one specimen the abnormality had caused a deviation from the median line of the anterior portion of the skull; and in another the incisors, after leaving the premaxilla, had formed a complete circle and grown into the palate, causing starvation and death of the animal.

The following papers were read:—

1. On some new Species of Spiders belonging to the Families *Pisauridæ* and *Senoculidæ*; with Characters of a new Genus. By Frederick Pickard-Cambridge, B.A., F.Z.S.

[Received January 10, 1903.]

(Plates XIV. & XV.[1])

While working out the Spiders of the two families *Pisauridæ* and *Senoculidæ* of Central America for the 'Biologia,' opportunity was kindly offered by Mr. R. I. Pocock for an examination of the material in the British Museum Collection, with the result

[1] For explanation of the Plates, see p. 168.

that a new genus and eight new species were found, several of them occurring amongst those collected by myself on the Lower Amazons in 1895–6.

The Spiders belonging to the *Pisauridæ* are interesting from the fact that they run freely and with great rapidity over the surface of the water, even in a strong current. One of the genera, *Dolomedes*, and another, *Thalassius*, have both been credited with capturing and devouring small fish of various kinds; and of the latter genus Mr. A. N. Stenning, himself formerly a gamekeeper, whose observations are likely to be trustworthy, declares that he has found members actually devouring the small fry of a variety of trout which occurs in South Africa, some of the culprits being now in the Museum Collection. Other notes on the habits of these interesting Spiders will be found under the genus *Trechalea*.

Species described or figured below.

Thaumasia velox E. Simon, ♀, p. 154, Pl. XIV. fig. 1.
,, *annulipes*, sp. nov., ♀, p. 154, Pl. XIV. fig. 2.
Dossenus marginatus E. Simon, ♀, p. 155, Pl. XIV. figs. 3–5.
Paradossenus nigricans, sp. nov., ♀, p. 155, Pl. XIV. figs. 6–9.
Thanatidius spinipes, sp. nov., ♀, p. 156, Pl. XIV. figs. 10–12.
Senoculus parallelus E. Simon, ♀, p. 166, Pl. XIV. fig. 13.
,, *albidus*, sp. nov., ♀, p. 168, Pl. XIV. fig. 14.
Trechalea longitarsis C. L. Koch, ♂ ♀, p. 160, Pl. XV. figs. 13–17.
,, *keyserlingi*, sp. nov., ♀, p. 163, Pl. XV. figs. 1, 2.
,, *urinator* E. Simon, ♂ ♀, p. 161, Pl. XV. figs. 3–5 *a*.
,, *ellacombei*, sp. nov., ♀, p. 161, Pl. XV. fig. 6.
,, *macconnelli* Poc., ♂, p. 162, Pl. XV. figs. 7, 8.
,, *connexa* O. P.-Cambr., ♂, p. 162, Pl. XV. figs. 9, 10.
,, *extensa* O. P.-Cambr., ♂, p. 162, Pl. XV. figs. 11, 12.
,, *amazonica*, sp. nov., ♂ ♀, p. 163, Pl. XV. figs. 18–20.
Hesydrus palustris E. Simon, ♂ ♀, p. 165, Pl. XV. figs. 22–25.
,, *habilis* O. P.-Cambr., ♂, p. 165, Pl. XV. fig. 21.

Fam. Pisauridæ.

Synopsis of Genera dealt with below.

A. Tibia i. with four (2–2–2–2) or five (2–2–2–2–2) paired spines beneath, the last pair very small and apical. Protarsi i. with three or four pairs beneath.
A[1]. Tibia i. with four pairs of spines beneath. Protarsi i.–iv. with a single small central apical spine beneath. Sternum produced into a long narrow conical point between coxæ iv.
i. Tarsi shorter, not flexible. Protarsi i. with three (2–2–2) paired spines beneath.
aa. Lower margin of fang-groove with 3 teeth.
a. Tibial and protarsal spines comparatively short, only two or three times as long as the diameter of the segment.
* Anterior row of eyes wider than that formed by the posterior centrals. Central posterior eyes nearer to each other than to the laterals.
a[1]. Teeth on lower margin of fang-groove not equidistant, the 3rd more remote..... *Thaumasia* Perty.

*b*¹. Teeth on lower margin of fang-groove equidistant	*Tinus* F. P.-Cambr.
** Anterior row of eyes not wider than that formed by the posterior centrals. Central posterior eyes much further apart than each is from the lateral	*Enna* O. P.-Cambr.
b. Tibial and protarsal spines comparatively very long, the longest being quite two thirds the length of the whole segment...	*Dossenus* E. Simon.
bb. Lower margin of fang-groove with 4 teeth, the 3rd smaller	*Paradossenus*, gen. nov.
ii. Tarsi long and flexible. Protarsi i. with four (2–2–2–2) paired spines beneath.	
*a**. Legs subequal in pairs, 4—2 and 1—3. Mandibles conspicuously gibbous above, glabrous, more distinctly carinate on the outer side (males). Lower margin of fang-groove with 3 teeth	*Hesydrus* Simon.
*b**. Legs unequal, 4, 2, 1, 3. Mandibles not conspicuously gibbous above, hairy, less carinate (males). Lower margin of fang-groove with 3, 4, or 5 teeth	*Trechalea* Thorell.
B¹. Tibia i. with five pairs of spines beneath. Protarsi i.–iv. with two apical spines beneath. Sternum very broad between coxæ iv., not forming a point	? *Thanatidius* E. Simon.
B. Tibia i. with 9–10 pairs of spines beneath, the last pair not apical. Protarsi i. with 8 or 9 pairs of spines beneath	*Syntrechalea* F. P.-Cambr.

If the above genera be separated by the perhaps more easily observed character furnished by the eye-formula, then the table would run as follows :—

A. Anterior row of eyes not or only a little wider than the posterior central row.
  a. Anterior row of eyes not wider than the posterior central row... { *Enna*. *Dossenus*.
  b. Anterior row of eyes a little, but distinctly, wider than the posterior central row ..... *Paradossenus*. *Tinus*. *Thaumasia*. *Hesydrus*. *Trechalea*. *Syntrechalea*.
B. Anterior row of eyes much wider than the posterior central row, as wide as the posterior lateral row ..... *Thanatidius*.

Note.—(1) The number of protarsal spines in some species of *Trechalea* are difficult to locate, and the character is thus rendered less valuable.

(2) One cannot be quite certain that *Thanatidius* has been correctly identified.

(3) *Tinus* is closely allied to *Drances* Simon, but the latter has, according to this author, no apical pair of spines beneath tibia i. and ii., while they are present in the former. The name *Drances* (not *Drances*) was used by Champion for Coleoptera in 1889.

(4) In the Biologia Centr.-Amer., Arach. Aran. ii. p. 312, I have referred the species *Hesydrus jullieni* Simon to *Enna* O. P.-Cambr. on the ground that they have the characters, the tarsi flexible and central posterior eyes 2 diameters apart, in common. This genus therefore comprises Simon's *Hesydrus* Sect. 2 *a*, while *Hesydrus*, as here diagnosed, comprises his *Hesydrus* Sect. 1 *a*.

Genus Thaumasia Perty.

Del. Anim. Art. Bras. p. 192 (1833). Type, *T. senilis* Perty.

Species recorded.

1. *T. senilis* Perty, loc. cit. ..... Brazil.
2. *T. marginella* (C. L. Koch) ..... (Sub *Dolomedes*.)

3. *T. scoparia* (E. Simon) ..... (Sub *Saltuinus*.)
4. ? *T. scapularis* (C. L. Koch) ..... (Sub *Dolomedes*.)
5. ? *T. binotata* (C. L. Koch) ..... (Sub *Dolomedes*.)
6. *Thaumasia velox* Simon, Ann. Soc. Ent. Belg. xlii. p. 18 (1898) ..... Brazil.

Thaumasia velox Simon. (Plate XIV. fig. 1.)

Loc. cit. Type ♂, in coll. E. Simon. Total length 8 mm.

Thaumasia velox F. P.-Cambr. Biol. Centr.-Amer., Arach. Aran. ii. p. 309, t. 30. figs. 5, 5 *a–c* (♂).

The type of this species (♂) was taken on the Amazons, and, short of first-hand evidence, I do not doubt that the male and female, taken by myself amongst the foliage on the margin of a small "furo" in the Parana Buyassu, near Breves, Lower Amazons, must be referred to this species.

The male identified as belonging to this species from Guatemala may possibly be not identical, but it is impossible to be certain with but one example from each locality.

The female has not been before described, but a figure of the vulva is given on the Plate. For figures of the male see Biol. Centr.-Amer. *loc. cit.* above.

Hab. Lower Amazons: Santarem; Breves, Parana Buyassu (*F. P.-C.*, 1895–96); Rio Tocantins, S. Paulo de Olivença (*de Mathan*); Guatemala (*Sarg*).

7. Thaumasia annulipes, sp. nov., ♀. (Plate XIV. fig. 2.)

Type ♀, in coll. Brit. Mus. Total length 5·5 mm.

♀.—*Colour.* Carapace deep brown, with pale yellow narrow central band, slightly dilate behind eyes. Abdomen brown, shoulders and anterior lateral portion deep black. Legs pale yellow, femora annulated with dusky brown.

Structure. Carapace horizontal above, convex and abruptly deflected behind. *Eyes*: posterior row recurved, subequal, equidistant; laterals on a stout black tubercle. Anterior row straight or slightly procurved, wider than width occupied by posterior centrals. Anterior eyes equidistant, centrals larger. Clypeus more than three times the height of the diameter of anterior centrals. *Mandibles* long and stout. Fang-groove with three denticles on both margins. *Sternum* cordiform, posterior angle attenuate, produced, its apex extending as far as the pedicle. *Coxæ of pedipalp* long, straight, slightly dilate and rounded at apex. *Labium* half the length of maxillæ, broad, squarely truncate at apex. *Legs* 4, 1, 2, 3; iii. the smallest, extending as far as apex of tibia iv. Tibia i. and ii. with 2–2–2 spines beneath; 1—1 lateral on apical half; 1—1 at base and apex above; 2 at apex beneath. Protarsus i. and ii. with 2–2–2 spines beneath and 1 at apex; 1—1 on each side; none above. For *vulva*, see Pl. XIV. fig. 2.

Several females of this small Spider were taken by myself in the neighbourhood of Mañaos, Lower Amazons, 1895–6.

Genus Dossenus Simon.

Hist. Nat. Ar. 2, ii. p. 314. Type, *D. marginatus* E. Simon. Lower Amazons.

Dossenus marginatus E. Simon. (Plate XIV. figs. 3–5.)

Ann. Soc. Ent. Belg. xlii. 1898, p. 19. Type ♀, and androtype ♂ in coll. E. Simon. Total length, ♀, 7·7 mm.

Two adult females of a Spider, which I feel pretty certain must be referred to this species, were taken by myself at Breves and Pará, and are now in the British Museum Collection. The spines on the legs are very long in comparison with those of allied genera.

Hab. Isl. Trinidad; Brazil: Amazons; Matto Grosso (*Germain*); Lower Amazons, Pará, Breves (Parana Buyassu, *F. P.-C.*, 1895–96).

Paradossenus, gen. nov.

Type, *P. nigricans*, sp. n. Lower Amazons.

Lower margin of fang-groove with 4 teeth, the 3rd being smaller. Tarsi short, straight, not flexible. Protarsi i. with 3 paired spines beneath; protarsi of all four pairs with a single central apical spine beneath. Tibia i. with four paired spines beneath, the last pair apical. Sternum produced into a conical point between coxæ iv. Spines on legs short, two to three times the diameter of the segment. Posterior row of eyes recurved; eyes subequal, centrals one diameter apart, two and a half from the laterals, which are set on a low tubercle. Anterior row straight or very slightly procurved, slightly wider than the central posterior row. Clypeus one and a half times the height of the diameter of an anterior central eye.

Legs 1, 2, 4, 3—iii. very short, extending as far as two-thirds of tibia iv.

Paradossenus nigricans, sp. nov. (Plate XIV. figs. 6–9.)

Type ♂, 8 mm.; gynetype ♀, 8·5 mm.—carap. 3·75 mm. In coll. Brit. Mus.

♂ ♀.—*Colour.* Carapace dull yellow-brown, with two longitudinal dark brown bars on each side of the pale central line, the whole being almost entirely clothed with yellow-grey scale-like hairs. Margins of carapace reticulated with fine dusky lines. The anterior portion of the brown bars presents within their margin a narrow elongate accent-like pale mark. *Abdomen* pale yellow; dorsal area with a broad longitudinal dark brown (sometimes paler) foliated band, becoming narrowed towards the spinners, from the centre of whose lateral margin, on both sides, issues an oblique interrupted lateral bar. The centre of the foliated band is occupied by a pale lanceolate band, much attenuated towards the spinners, its basal portion again occupied by a broad lanceolate dark band, scarcely reaching the centre of the

abdomen. Lateral area mottled with dusky brown; ventral surface pale yellow, unicolorous. *Legs* entirely yellow: i. and ii. very faintly annulated and speckled with dusky brown, iii. and iv. annulated, in some cases very richly, with black or brown. *Mandibles* red-yellow, with a large brown patch on each in front.

N.B.—These colours are very variable and in some cases the central dark band within the inner pale band on the abdomen is itself pale.

The *vulva* consists of two parallel plates, which have a prominent angle on their inner margin. Between these, in front, lies a deep transverse semicircular depression, and a convex central piece, with a few shallow longitudinal grooves, is situated between the plates.

For figures of tibial spur of male palpus and the vulva, see Plate XIV. figs. 7, 9.

These spiders are very abundant on the Lower Amazons, racing over the surface of the water with legs extended and body flat, and are exceedingly difficult to catch. None of the females had egg-cocoons with them, but they probably carry them in the same position as *Trechalea*, for in habits and general appearance these spiders are very similar to those belonging to the latter genus.

Hab. Lower Amazons: Breves, Parana Buyassu (*F. P.-C.*, 1895–6).

Genus Thanatidius E. Simon.

Hist. Nat. Ar. 2, ii. p. 293. Type, *T. dubius* (Hentz).
N. America.

The following three species are referred to this genus by Simon:—

1. *T. dubius* (Hentz), Bost. J. N. H. v. p. 449 (1847). (Sub *Thomisus.*)
2. *T. tænius* (Hentz), loc. cit. ..... (Sub *Thomisus.*)
3. *T. undulatus* (Keys.), Verh. z.-b. Ges. Wien, p. 486 (1887). (Sub *Tetragonophthalma.*)

4. Thanatidius spinipes, sp. nov. (Plate XIV. figs. 10–12.)

Type ♀ in coll. Brit. Mus. Total length 6 mm.

Hab. Parana Buyassu, Breves, Lower Amazons.

♀.—*Colour.* Carapace, mandibles, sternum, and legs bright, unicolorous orange. Abdomen olive-green, with a central band of cretaceous-white pigment-cells.

Structure. Carapace nearly circular, ocular region produced, parallel-sided, slightly raised. Thoracic region gibbous, abruptly deflected behind. *Eyes*: posterior row strongly recurved, eyes subequal, less than one diameter apart, equidistant; laterals on a stout conical tubercle. Anterior row strongly procurved; eye-tubercles subequal, less than one diameter apart, equidistant, much wider than the width occupied by lateral posteriors. *Clypeus*, in centre as high as four diameters of anterior central eyes.

Mandibles long, slender, more than twice as long as height of clypeus. *Fang-groove* with three denticules on lower margin. *Maxillæ* long, parallel, dilate at apex; labium broad, half the length of maxillæ, truncate at apex.

Sternum longer than broad, cordiform, produced posteriorly between coxæ iv. into a *broad rounded plate*, the coxæ being their own diameter apart. *Legs* 1, 4, 2, 3. Femora with two long dorsal spines and several others on the sides and apex. Femur i. with two long spines in front in apical half. Tibia i. and ii. with 2–2–2–2–2 long spines beneath, the longest (the basal) being half as long as the segment itself. 1—1 lateral spines; 1—1 dorsal. Protarsus i. and ii. with 2–2–2–2 long spines beneath (basal pair longest): 1—1 lateral, 1—1 dorsal. Spines on tibia and protarsus iii. and iv. numerous, but less regular. Patellæ 1–4 with a single long apical spine. *Scopula* absent. Tarsal claws 3, superiors with three or four denticules beneath. *Spinners* 6, posteriors longest. *Pedipalp* with large tarsal claw, having 3 very long denticules beneath towards base. *Vulva*, see Pl. XIV. fig. 12.

Hab. A single ♀ from the Parana Buyassu, near Breves, Lower Amazons.

Genus Trechalea Thorell, 1869 (nom. nov. for *Triclaria*).

Type, *T. longitarsis* (C. L. Koch), Colombia. Sub *Triclaria* (1848), nom. præocc. by Wagler for *Aves* (1832).

The following characters are common to all the species mentioned below:—Teeth on upper margin of fang-groove 3, on the lower, 3, 4, or 5. Tarsi long and flexible. Tibia i. with four pairs of spines beneath, the last pair small and apical, besides two lateral spines. Protarsi i. with four pairs of spines beneath (often irregularly situated); protarsi of all four pairs with a small central apical spine beneath. Anterior row of eyes slightly recurved, extending laterally slightly beyond the posterior centrals. Lateral anteriors smaller than the central anteriors. Legs variable in length, 4, 2, 1, 3. Clypeus variable in height, porrect, and the eyes also variable in their relative positions.

As regards the type-species of the genus, two distinct forms have been identified as *longitarsis* of Koch—one by Keyserling, now in coll. Brit. Mus., a female, having 5 teeth; the other by Simon (Ann. Soc. Ent. Belg. xlii. p. 20, 1898), male and female, having 3 teeth. Since they cannot both be the true *longitarsis*, I describe Keyserling's identification as a new species, for it is totally distinct from examples from Colombia, now before me, whence the *type* of the genus originally came. It forms, indeed, the type of a distinct group, so entirely different is the form of the vulva from that of the typical *Trechalea* from Colombia.

At present, however, although the identity of *T. longitarsis* cannot be settled with absolute certainty until an examination of the type-specimen (if it still exists in the Imperial Museum at

Berlin) has been made, the examples from Colombia are regarded and here described as *T. longitarsis* C. L. Koch. All of the species described and recorded below seem to be good and distinct, though of course much more material from all parts is required for comparison and the confirmation of characters.

The habits of these spiders are very interesting, for although they are not amphibious in the true sense of the term, as are *Argyroneta* and *Desis*, they are quite at home on the water, and speed along over the surface with great ease and rapidity, the hairy clothing of the legs being waterproof. When racing away over the water, they are not easy to distinguish from the large Hemipterons (probably a species of *Ranatra*) of similar habit, when the two creatures happen to be together in the same locality. On being pursued over the water, the spiders will rush up the sides of the boat and take refuge under the boards, but I have never observed them dive below the surface as do *Pirata*, *Dolomedes*, and some other Pisauridæ. Whether, as has been reported of certain species of *Dolomedes* and *Thalassius*, the spiders actually prey upon small fish of various kinds, I cannot say from actual experience, though the long flexible legs and exceedingly sharp claws are well adapted for the pursuit and capture of such prey in their native element. I may add that McCook's records of the fish-catching capacity of *Dolomedes* (Amer. Spid. vol. i. p. 236 and iii. p. 66) has recently received confirmation by Mr. A. N. Stenning in South Africa. He tells us that *Thalassius*, a genus representing *Dolomedes* in the Ethiopian Region, has been often observed by himself in the act of devouring the small fry of a species of trout, and calls the attention of pisciculturists in those regions to the fact, and begs them to keep an eye on these spiders.

On a swampy island in the large largo opposite Santarem on the Amazons, I have taken examples of one beautiful species squatting flat, like Sparassids, on the trunks of the trees, where their hoary-white hairs and mottled legs and body afforded them excellent protective colouring. Nor do they resemble Heteropods merely when at rest, for when disturbed they dash round to the opposite side of the tree-trunk with all the rapidity of a *Selenops*. The egg-cocoon, as in many Pisaurids, is carried by the female attached to the central pair of spinners at the tail-end of the abdomen; and it is curious to note how, when these females stop suddenly in headlong flight, the weight of the cocoon swings them round on the water, and carries them along backwards for some distance.

The species recorded and described below may be recognized by the following characters:—

Males.

A. Lower margin of fang-groove with 4 teeth, the third smaller. Legs unicolorous ..... *urinator* E. Simon.

B. Lower margin of fang-groove with 3 subequal teeth. Legs more or less spotted or annulated.
I. Legs longer in proportion, leg iv. being about 8 times longer than the carapace.
a. Third tooth on lower margin of fang-groove more remote from the others.
a^1. Tibia of pedipalp from one-half to twice longer than broad; tibial spur distinctly unculate at apex, not concave on inner side. Embolus of bulb with a long conspicuous spur at its base. — *longitarsis* C. L. Koch (sec. F. P.-C.).
b^1. Tibia of pedipalp not longer than broad; tibial spur not unculate at apex, concave on inner side, the inner margin having a prominent angle. Embolus of bulb without any long spur, but having two chitinous ridges — *macconnelli* Pocock.
b. Third tooth on lower margin of fang-groove not remote, the 3 teeth almost equidistant.
a^2. Tibial spur not unculate at the apex. Embolus of bulb without any long spur — *connexa* O. P.-Cambr.
b^2. Tibial spur unculate at its apex. Embolus of bulb with a long spur at its base — *extensa* O. P.-Cambr.
II. Legs shorter in proportion, leg iv. being 5–6 times longer than the carapace — *amazonica*, sp. n.

An alternative table for Males.

A. Embolus of bulb with a long conspicuous erect black spur in its basal cavity.
a. Lower margin of fang-groove with 4 teeth — *urinator*.
b. Lower margin of fang-groove with 3 teeth.
a^1. Central posterior eyes one diameter apart; apical portion of embolus shorter, more distinctly flanged on both sides; 3rd tooth more remote; tibial spur less broad and flattened — *longitarsis*.
b^1. Central posterior eyes less than half a diameter apart; apical portion of embolus longer, less conspicuously flanged on the lower margin; 3rd tooth not remote; tibial spur broader and more flattened — *extensa*.

B. Embolus of bulb without any erect black spur in its basal cavity.
a^2. Tibial spur straight, blunt at apex.
a^3. Tibial spur forming a conspicuous angle on its inner margin. Tooth 3 remote from the others; apex of embolus less broadly flanged on its upper margin — *macconnelli*.
b^3. Tibial spur without angle on inner margin. Teeth equidistant; apex of embolus more broadly flanged on its upper margin — *connexa*.
b^2. Tibial spur strongly curved, pointed at apex — *amazonica*.

Females.

A. Lower margin of fang-groove with 5 teeth, the 4th very small, situated on the inner side between the 3rd and 5th. Vulva without any central tongue-like sclerite, but with two small blunt cusps in the middle of the anterior margin, and an oblique elongate lateral lobe on each side, converging behind the cusps — *keyserlingi*, sp. n.

B. Lower margin of fang-groove with 3 (or 4) teeth. Vulva with a well-defined central tongue-like sclerite.
a. Lower margin of fang-groove with 4 teeth, the 3rd smaller — *urinator* E. Simon.

b. Lower margin of fang-groove with 3 subequal teeth.
a[1]. Size much larger, 25 mm. Leg iv. at least ten times longer than the carapace. Third tooth on lower margin of the fang-groove slightly more remote from the second than the latter is from the first.
a[2]. Central tongue-like sclerite much narrower, dumb-bell-shaped, about equally dilate at each end ..... *ellacombei*, sp. n.
b[2]. Central tongue-like sclerite much broader, almost as broad in the middle as posteriorly, much broader anteriorly but somewhat variable ..... *longitarsis* C. L. Koch.
b[1]. Size much smaller, 11 mm. Leg iv. not more than 5–6 times longer than the carapace. Teeth on lower margin of fang-groove equidistant. Central cavity of vulva long and narrow, straight on the inner margins; central tongue elongate, not dilate anteriorly, but narrowed..... *amazonica*, sp. n.

1. TRECHALEA LONGITARSIS (C. L. Koch). (Plate XV. figs. 13–17.)

Die Arach. xv. p. 65, t. 522. fig. 1462 (sub *Triclaria*).

? Trechalea longitarsis E. Simon, Ann. Soc. Ent. Belg. xlii. 1898, p. 20.

Type ♀, in coll. Mus. Imper. Berlin. *Hab.* Colombia.

Although the identity of this species cannot be satisfactorily settled without reference to the *type-specimen*, if it still exists, I give a description and figures of the characters of a form with annulated legs which was taken in Colombia. If the type no longer exists, and no more exact locality than "*Colombia*" can be ascertained for the type-specimen, then the examples here described stand as "*topotypes*"—examples from the same locality in which the type was taken—and will serve as a standard of comparison for the species in the place of the original type.

Had Simon given more definite characters (for the majority of the species of *Trechalea* possess 3 teeth) which would enable us to recognize his identification of *T. longitarsis* with any certainty, and if these (for he makes no mention of the locality) were taken in Colombia, then *his examples* would be the recognized "*topotypes*" to which we should have to refer for an identification of *T. longitarsis* (C. L. Koch).

Present identification of *T. longitarsis* (sec. F. P.-Cambr.).

Total length, ♂ 20, ♀ 25 mm.—♀. Leg i. 61; ii. 68; iii. 55; iv. 75 mm. Tib. i. 15; iv. 16·5 mm. Prot. iv. 21 mm.

Examples in coll. Brit. Mus. from Colombia.

♂ ♀.—*Colour*. Carapace rich brown-black, with a pale orange Λ-shaped spot behind the eyes, having a central dusky line, and one on each side; a pale rufous-white, narrow, submarginal band, and a narrow black velvety marginal band. *Abdomen* brown, with a black central foliated band: a more exact description is impossible from dried and wrinkled examples. Sternum and ventral area dull yellow-brown. Legs brown, very distinctly annulated with rufous-white hairs, protarsi less distinctly, tarsi

not at all. Mandibles black, clothed with hoary-white hairs in front.

Structure. General characters similar to those of other species of the genus. Central posterior eyes one diameter apart (less in ♂); clypeus six times as high as the diameter of an anterior central eye (in ♂ four times).

Vulval area broader than long, rounded, rectangular; central tongue distally broad, widely dilate basally; variable in different examples.

Palpus. Tarsus twice as long as broad; tibia two-thirds the length of the tarsus; one-fourth longer than the patella. Tibial spur broad basally, curved apically, terminating in a small hook, having on the inner side a slightly serrated ridge. The embolus of the bulb has a stout erect spur springing from the cavity below the apex of the lamina of the bulb, while the embolus itself is short, strongly curved, and conspicuously flanged on each side.

Hab. Colombia, dried examples (♂ & ♀); Venezuela, dried examples (♂ & ♀); also many examples in spirit, in coll. Brit. Mus.

2. Trechalea urinator E. Simon. (Plate XV. figs. 3–5 *a*.)

Ann. Soc. Ent. Belg. xlii. p. 20 (1898).

Type ♂, gynetype ♀, in coll. E. Simon. Total length (♂, ♀) 20–25 mm.—(♂). Carap. 11. Leg i. 74; ii. 82; iii. 62; iv. 85 mm. Tib. i. & iv. 19·5 mm. Prot. iv. 22 mm.

Both sexes with 4 teeth on the lower margin of the fang-groove. Legs 4, 2, 1, 3. Clypeus 3–3½ times in height the diameter of an anterior central eye.

Carapace, abdomen, and legs entirely without dark bands or annules, or these are at least very faint; entirely clothed with dusty olive-brown hairs and pubescence.

Palpus. Tibia 1½ times longer than broad; tibial spur slender, its apex bent over, forming a single small hook. The inner apophysis deeply impressed across the middle, forming two blunt cusps.

Vulva with a short broad central tongue, broadly dilate basally.

If I am correct in my identification of Simon's species, it is a common Spider throughout Ecuador.

Hab. Ecuador: Guayaquil, Loja; Rio Durango; Bulun; Cachavi; Cavondelet; Paramba; Salidero (*Rosenberg*).

3. Trechalea ellacombei, sp. nov. (Plate XV. fig. 6.)

Type ♀, in coll. Brit. Mus. Total length 25 mm. Carap. 10 mm. Leg i. 68; ii. 75; iii. 60; iv. 80 mm. Tib. i. 17; iv. 17·5 mm. Prot. iv. 22·5 mm.

Lower margin of fang-groove with 3 teeth. Legs 4, 2, 1, 3. Clypeus 4 times the height of the diameter of an anterior central eye. The whole of the central area of the carapace black, with margins and striæ flavous. Abdomen too much shrivelled to admit of the coloration being recorded. Legs very deeply streaked and

annulated with black, except the tarsi. Vulva with a long central tongue, dilate basally, and its apex incurved.

This species is nearly allied to *T. urinator*, but may be recognized by the annulated legs, the possession of only 3 teeth on the mandible, and by the form of the vulva.

Hab. Surinam, Bergen Daal (collected by Mr. C. W. Ellacombe).

4. Trechalea macconnelli Pocock. (Plate XV. figs. 7, 8.)

Trans. Linn. Soc. Lond., Zool. (2) viii. 2, p. 67, Sept. 1900.

Type ♂, in coll. Brit. Mus. Total length 16 mm. Carap. 9 mm. Leg i. 64; ii. 70; iii. 55·5; iv. 73. Tib. i. & iv. 17 mm. Prot. iv. 18 mm.

Lower margin of fang-groove with 3 teeth. Legs 4, 2, 1, 3. Clypeus twice the height of the diameter of an anterior central eye. Carapace with a large black patch in the centre, its margins scalloped by the flavous margin round the carapace and the pale striæ. Abdomen dusky with a flavous pattern and two flavous spots above the spinners. *Palpus*: Tibia not, or scarcely, longer than broad. Tibial spur slender, concave lamelliform, its lower edge slightly serrate; convex and incurved at the apex; seen from above it has a Λ-shaped emargination. The inner apophysis is cylindrical, low and impressed across the top.

Hab. British Guiana: Mt. Roraima (collected by Messrs. Quelch & McConnell).

5. Trechalea connexa (O. P.-Cambr.). (Plate XV. figs. 9, 10.)

Triclaria connexa O. P.-Cambr. Biol. Centr.-Amer., Arach. Aran. i. p. 233, t. 30. figs. 1, 1 *a–e* (♂), 1898.

Trechalea connexa F. P.-Cambr. loc. cit. ii. p. 313, t. 30. fig. 17 (♂), 1902.

Type ♂, in coll. Godman & Salvin. Total length 14 mm. Carap. 7 mm. Leg i. 40; ii. 45; iii. 39; iv. 48 mm. Tib. i. 10; ii. 11 mm. Prot. iv. 13·5 mm.

Lower margin of fang-groove with 3 teeth. Legs 4, 2, 1, 3. Clypeus as high as two diameters of an anterior central eye. Carapace flavous, streaked and mottled with brown. Abdomen dark brown. Legs decidedly annulate. *Palpus*: Tibia half longer than broad; spur, seen from below, without any hook at its apex. Embolus of palpus without two ridges as in *T. macconnelli*, shorter and more broadly flanged on its anterior margin.

Hab. Mexico, Atoyac (*H. H. Smith*).

6. Trechalea extensa (O. P.-Cambr.). (Plate XV. figs. 11, 12.)

Triclaria extensa O. P.-Cambr. loc. cit. i. pp. 174, 233, t. 22. figs. 10, 10 *a–f* (♂), 1896.

Trechalea extensa F. P.-Cambr. loc. cit. ii. p. 313, t. 30. figs. 16, 16 *a, b* (♂), 1902.

Type ♂, in coll. Godman & Salvin. Total length 20 mm. Carap. 10 mm. Leg i. 69; ii. 77; iii. 58; iv. 82 mm. Tib. i. 17; iv. 19 mm. Prot. iv. 20 mm.

Lower margin of fang-groove with 3 teeth. Legs 4, 2, 1, 3. Clypeus 3 times as high as the diameter of an anterior central eye. Carapace unicolorous flavous, margined with dusky black. Abdomen unicolorous brown, with a short central anterior pale dorsal bar. Legs faintly annulate. *Palpus*: Tibia twice as long as broad; spur, seen from above, stout, projecting, curved, with a stout sharp cusp or hook on the inner side at the apex, very similar to but much stouter than in *T. urinator*. Inner apophysis deeply impressed in the middle. Embolus as in *T. longitarsis*, but less broadly flanged.

Hab. Guatemala (*Sarg*).

7. Trechalea amazonica, sp. nov. (Plate XV. figs. 18–20.)

Type ♂, gynetype ♀, in coll. Brit. Mus. Total length ♂ 10; (♀ 15 mm.). Carap. 6 mm. Leg i. 31; ii. 32; iii. 29; iv. 37·5 mm. Tib. i. & iv. 7–8 mm. Prot. i. & v. 10 mm.

Lower margin of fang-groove with 3 teeth. Clypeus in height equal to 1½ diameters of an anterior central eye. Legs 4, 2, 1, 3. Carapace dull straw-yellow; margins and striæ slightly suffused with dusky brown, produced by fine dark hairs; mottled with patches of white hairs, angular on margins; clypeus fringed and clothed with hoary-white hairs. Mandibles, pedipalps, and a spot on ocular area behind the eyes clothed with hoary-white hairs. *Abdomen* olive-green mottled with brown and hoary-white. Ventral area clothed with silver-white hairs. Sternum and legs dull yellow beneath, the latter brighter above; femora indistinctly annulated with dusky brown above; base of patella black. Tibiæ and protarsi with two broad dark annulations. Pedipalps also annulated with brown.

Vulva with a narrow oblong central cavity, its lateral margins straight and parallel, with an elongate central tongue, not dilated at either end, not incurved at apex, without any black shining bosses on each side.

The male and female here described were taken from the same trunk of a tree on a swampy island in the largo opposite Santarem. They were crouching on the bark like Sparassids, and when disturbed moved with great rapidity.

Hab. Lower Amazons: Santarem; Breves, Parana Buyassu; Pará (*F. P.-C.* 1895–6).

8. Trechalea keyserlingi, sp. nov. (Plate XV. figs. 1, 2.)

Type ♀, in coll. Keys. Brit. Mus. Total length 20 mm. Carapace 9·75 mm. Leg i. 44; ii. 46; iii. 36; iv. 49 mm. Tib. i. 11; ii. 11·5 mm. Prot. iv. 13 mm.

Lower margin of fang-groove with 5 teeth. Clypeus five times as high as the diameter of an anterior central eye. Legs 4, 2, 1, 3. Carapace with two broad central bands, widely separate behind the eyes, connivent behind; the clear space behind the eyes marked with lateral and central fine streaks. Abdomen with a broad deep-brown foliate band above, constricted just behind

the middle and again slightly above the spinners, broadly margined with pure white pubescence. Femora of legs deeply blotched and streaked above with black; tibiæ distinctly, protarsi indistinctly annulated. *Vulva* without any central tongue, but with two small cusps in the middle and two separate posteriorly converging lateral sclerites, quite distinct in form from that of any other species here recorded (see Plate XV. fig. 2).

This specimen was identified by Keyserling as *T. longitarsis* C. L. Koch. See p. 157.

Hab. Brazil, Rio Grande do Sul (*Keys. Coll.*).

Genus Hesydrus Simon, 1898 (June 30).

Simon, Hist. Nat. Ar. 2, ii. p. 315. Type, *H. palustris* Simon. Ecuador.

The species belonging to this genus are very closely allied to *Trechalea*, but form a small group chiefly distinguishable by the glabrous, gibbous mandibles, with a well-marked carina on the outer side, in the male sex. The legs in both sexes are subequal in pairs 4–2, 1–3; being also much shorter in proportion than in *Trechalea*. Both margins of the fang-groove with 3 teeth. Eyes as in *Trechalea*, central posteriors slightly over one diameter apart; clypeus low and porrected. Tibia and protarsus i. with 2–2–2–2 spines beneath; protarsi 1–4 with a small central apical spine beneath.

In Biol. Centr.-Amer., Arach. Aran. ii. p. 305, I have referred the species given as the type of *Hesydrus* (sec. 2 *a*, *H. jullieni*) to *Enna* O. P.-Cambr., and the name *Hesydrus* is applicable to the species under sec. 1*a* with *H. palustris* as the type. It appears that Simon has somehow confused the characters of these two groups. In *Enna* (including *H. jullieni*) undoubtedly the clypeus is more vertical; the central posterior eyes are two diameters apart, or more, and the anterior row is not wider than the posterior central row; while the tarsi are straight and not flexible. But in *H. palustris* (for if not identical, the form before me is certainly congeneric with this species) the clypeus is porrect, the central posterior eyes one diameter apart, the anterior row wider than the posterior central, and the tarsi flexible; the eyes of the posterior row are certainly not equidistant, a character given for distinguishing *Hesydrus* from *Trechalea*. Fortunately, however, the citation of a definite type species enables one to rectify the confusion.

The two species known to me may be recognized by the following characters:—

a. Tibial spur of palpus, seen from above its apex, not bifid, slightly emarginate and prominent at its angles, but not incurving in the form of two teeth ..... *habilis* O. P.-Cambr.

b. Tibial spur of palpus, seen from above its apex, deeply bifid, its angles forming two sharp teeth curving inwards and downwards ..... *palustris* Simon.

1. Hesydrus palustris Simon. (Plate XV. figs. 22–25.)

Ann. Soc. Ent. Belg. xlii. 1898, p. 21 (♂, ♀)[1].

Type ♂, gynetype ♀, in coll. E. Simon. Total length ♂ 11 (♀ 16 mm.).—Carap. 6 mm. Leg i. 25; ii. 30; iii. 24·5; iv. 30 mm. Tib. i. 6; iv. 7 mm. Prot. iv. 10·5 mm.

Lower margin of fang-groove with 3 teeth. Legs 4–2, 1–3. Clypeus porrect, as high only as the diameter of an anterior central eye. Carapace dull flavous with dusky hairs. *Palpus*: Tibial spur short, concave lamelliform, deeply bifid at its apex, forming two small, sharp, incurving teeth. Inner apophysis elongate, not impressed across the middle, produced at its anterior apical angle to form a small cusp. *Vulva* with a broad central cavity, more than two-thirds the transverse width, concave on its lateral margins, having a long narrow central tongue, not dilate at either end, with a shiny black boss on each side, on the floor of the cavity; very variable in form.

Hab. Ecuador: Paramba (*Rosenberg*). Loja, Zamora[1].—Venezuela: Merida.

It is not certain that my identification of this species is correct, but it is highly probable.

2. Hesydrus habilis (O. P.-Cambr.). (Plate XV. fig. 21.)

Triclaria habilis O. P.-Cambr. loc. cit. i. pp. 173, 233, t. 22. figs. 9, 9 *a–f* (♂), 1896.

Trechalea habilis F. P.-Cambr. loc. cit. ii. p. 313, t. 30. fig. 15 (♂), 1902.

Type ♂ in coll. Godman and Salvin. Total length 10 mm. Carap. 5 mm. Tib. i. 5·5 mm. (other legs broken off or mutilated).

Lower margin of fang-groove with 3 teeth. Legs 2, 4, 1, 3 (sec. O. P.-C.). Clypeus as high as $1\frac{1}{2}$ diameter of an anterior central eye. Legs dull yellow-brown, slightly annulate. The colours of the carapace and abdomen appear to have faded. Mandibles glabrous shiny and very gibbous dorsally. *Palpus*: Tibia one-third longer than broad. Tibial spur, seen from above its apex, not bifid, its angles not forming sharp incurving teeth.

Hab. Guatemala: Costa Rica (*Sarg, Rogers*).

3. Hesydrus estabanensis E. Simon.

Ann. Soc. Ent. Belg. xlii. 1898, p. 20 (♂, ♀).

Type ♂, gynetype ♀, in coll. E. Simon. Total length ♂ ♀, 7 mm.

One would suspect, from the descriptions, that this species is congeneric with *H. palustris*, the males having the mandibles convex and carinate on their outer apical margin.

Hab. Venezuela: San Esteban.

4. Hesydrus bucculentus E. Simon.

Ann. Soc. Ent. Belg. xlii. 1898, p. 20 (♂).

Type ♂, in coll. E. Simon. Total length 10 mm.

The remarks made under the last species apply also to this.

Hab. Brazil: Rio (*Gounelle*).

Fam. Senoculidæ.

Genus Senoculus Taczanowski.

1872. *Senoculus* Tacz. Hor. Soc. Ent. Ross. ix. p. 106.—Type, *S. maronicus*.
1873. *Labdacus* O. P.-Cambr. Proc. Zool. Soc. Lond. p. 118.—Type, *L. monastoides*.
1880. *Platyctenus* Keys. Verh. z.-b. Ges. Wien, xxix. p. 338, note. Nom. nov. for *Senoculus* (nom. inappro. sec. Keys.).
1880. *Stenoctenus* Keys. Verh. z.-b. Ges. Wien, xxix. p. 340.—Type, *S. gracilis*.
1883. *Neothereutes* Holmb. Bol. Acad. Nac. Cienc. Cordoba, v. p. 35.—Type, *N. darwini* Holmb.

In a former paper, "Cteniform Spiders from the Lower Amazons &c.," Ann. Mag. Nat. Hist. (6) xix. p. 90, Jan. 1897, I have tabulated the characters of the known species of this genus so far as I could draw reliable characters from the existing descriptions.

The table is here re-modelled and includes additional species from Central America, published in the 'Biologia Centrali-Americana,' and a new species occurring in the British Museum Collection, of which a diagnosis is given below. I have not seen *S. parallelus* Simon, but it is certain that my example from the Lower Amazons belongs to that species, since M. Simon has kindly compared a figure of the vulva with that of his own type.

The following is a list of the species already published:—

1872. *S. maronicus* Tacz., ♀, St. Laurent de Maroni. Hor. Soc. Ent. Ross. ix. p. 106, t. iii. fig. 4.
1873. *S. monastoides* (O. P.-Cambr.), ♀, Brazil, Rio Grande. P. Z. S. Lond. p. 118.
1879. *S. rubromaculatus* Keys., ♀, Peru. Verh. z.-b. Ges. Wien, p. 339, pl. iv. fig. 30.
1880. *S. plumosus* (E. Sim.), ♀, Brazil, Pará. Bull. Soc. Zool. Fr. p. 154.
1880. *S. purpureus* (E. Sim.), ♀, Panama. Bull. Soc. Zool. Fr. p. 155.
1880. *S. parallelus* (E. Sim.), ♀, Brazil, Teffé. Bull. Soc. Zool. Fr. p. 156.
1880. *S. ruficapillus* (E. Sim.), ♂, Brazil, Pará. Bull. Soc. Zool. Fr. p. 154.
1880. *S. iricolor* (E. Sim.), ♂ ♀, Brazil, Teffé. Bull. Soc. Zool. Fr. p. 153.
1880. *S. gracilis* (Keys.), ♀, Peru, Aimable Maria. Verh. z.-b. Ges. Wien, p. 341, t. iv. fig. 29.
1883. *S. darwini* (Holmb.), ♀, Formosa, Chaco, Arg. Rep. Bol. Acad. Nac. Cienc. Cordoba, v. p. 35.
1896. *S. prolatus* (O. P.-Cambr.), ♂ ♀, Mexico, Atoyac. Biol. Centr.-Amer., Arach. Aran. i. p. 218, t. 28. figs. 3, 3*a–f* (♀).
1897. *S. pallidus* (F. P.-Cambr.), ♂, Brazil, Rio Janeiro. Ann. Mag. Nat. Hist. (6) xix. p. 92, pl. iv. fig. 5 (sub *Stenoctenus*).

1902. *S. canaliculatus* F. P.-Cambr., ♂ ♀, Panama, Bugaba. Biol. Centr.-Amer., Arach. Aran. ii. p. 350, t. 33. figs. 3 (♂), 4, 4*a* (♀).

The characters by which the species may be distinguished, so far as I can gather them from the descriptions, are as follows:—

Males.

A. Carapace and abdomen clothed with plumose hairs. — *iricolor* Simon.

B. Carapace and abdomen clothed with simple hairs.

I. Tibia i. and ii. with 9—10, protarsi with 8—9 long spines beneath on each side — *pallidus* F. P.-Cambr.

II. Tibia i. and ii. with 4—4 long spines beneath, protarsi with 5—5.

a. Anterior portion of ocular area almost vertical. — *ruficapillus* Simon.

b. Anterior portion of ocular area porrect, horizontal.

1. Apex of lamina round the inner anterior portion of the bulb of the palpus much broader and more deeply and broadly bifurculate — *prolatus* O. P.-Cambr.

2. Apex of lamina round the inner anterior portion of the bulb of the palpus much narrower and less deeply bifurculate (simply bifid and canaliculate) — *canaliculatus* F. P.-Cambr.

Females.

A. Carapace and abdomen clothed with plumose hairs.

1. Carapace deeply striate, central stria oval-elongate; tarsi i. and ii. with 4—4, protarsi i. and ii. with 3—3 long spines beneath — *plumosus* Simon.

2. Carapace scarcely striate, central stria short, subpunctiform; tibia i. and ii. with 5—5, protarsi i. and ii. with 4—4 long spines beneath — *iricolor* Simon.

B. Carapace and abdomen clothed with simple hairs.

a. Legs very long; tibia i. and ii. with long spines beneath, 10 on inner side, 9 on outer side.

a^1. The lateral lobes of the vulva bearing a rounded boss on the outer margin just behind the middle (see Keyserling's figure) — *gracilis* Keyserling.

b^1. The lateral lobes of the vulva without any rounded boss — *parallelus* Simon.

b. Legs shorter, tibia i. and ii. with only 4—4 or 5—5 long spines beneath.

aa. Tibia i. and ii. with 5—5 long spines beneath.

a^2. Posterior eyes very large, centrals less than a diameter apart, scarcely 1⅛ diameters from the laterals; anterior portion of ocular area almost vertical — *ruficapillus* Simon.

b^2. Posterior eyes moderate in size, centrals over a diameter apart, at least two diameters from the laterals. Anterior portion of ocular area porrect — *monastoides* O. P.-Cambr.

bb. Tibiæ i. and ii. with 4—4 long spines beneath.

a^3. Protarsi i. and ii. with 3—3 long spines beneath, besides lateral and apical spines... — *albidus* F. P.-Cambr.

b^3. Protarsi i. and ii. with 5—5 long spines beneath, besides lateral and apical spines.

a^4. External sclerites of vulva evenly rounded on their outer margin, sinuously concave on their inner margin, their apices (anterior portion) sharp, with a minute cusp on their outer margin — *prolatus* O. P.-Cambr.

b^4. External sclerites of vulva emarginate on their outer sides, evenly convex on their inner margins, their apices forming a broad hook, not very sharp at the point, without any minute cusp — *canaliculatus* F. P.-Cambr.

SENOCULUS ALBIDUS, sp. nov. (Plate XIV. fig. 14.)

Type ♀, in coll. Brit. Mus. Total length 14 mm.

In general appearance this species is similar to others of the genus, the legs being clothed with a lateral fringe of curving simple silky white hairs. The abdomen is also clothed at the apex on each side with long pure-white hairs. The vulva consists of two large oblong convex sclerites convergent forwards, and somewhat concave at this point, see Plate XIV. fig. 14, where also the vulva of *S. parallelus* Simon is figured (fig. 13).

Hab. Brazil; Rio Janeiro.

NOTE.—Of *S. purpureus* (E. Simon) and *S. darwini* (Holmberg) I cannot give any reliable characters. *S. maronicus* Tacz., the type of the genus, is, according to the author, immature, and no mention is made of the number of spines on the legs.

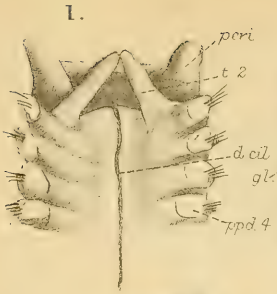
EXPLANATION OF THE PLATES.

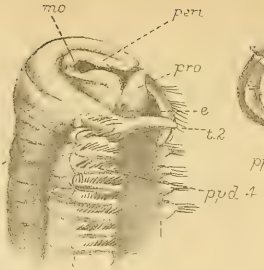
PLATE XIV.

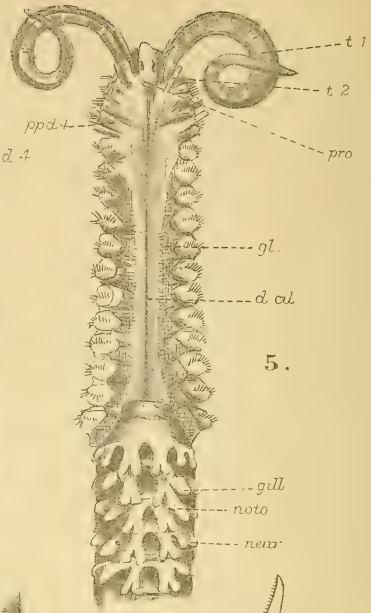
Fig. 1. *Thaumasia velox*, ♀, vulva, p. 154.
2. „ *annulipes*, ♀, vulva, p. 154.
3. *Dossenus marginatus*, ♀, p. 155.
4. „ „ ♀, vulva.
5. „ „ ♀, eyes.
6. *Paradossenus nigricans*, ♀, p. 155.
7. „ „ ♀, vulva.
8. „ „ ♀, eyes.
9. „ „ ♂, tibial spur of palpus.
10. *Thanatidius spinipes*, ♀, eyes, p. 156.
11. „ „ ditto, in front.
12. „ „ ♀, vulva.
13. *Senoculus parallelus*, ♀, vulva, p. 166.
14. „ *albidus*, ♀, vulva, p. 168.

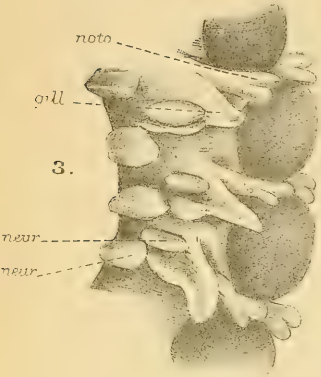
PLATE XV.

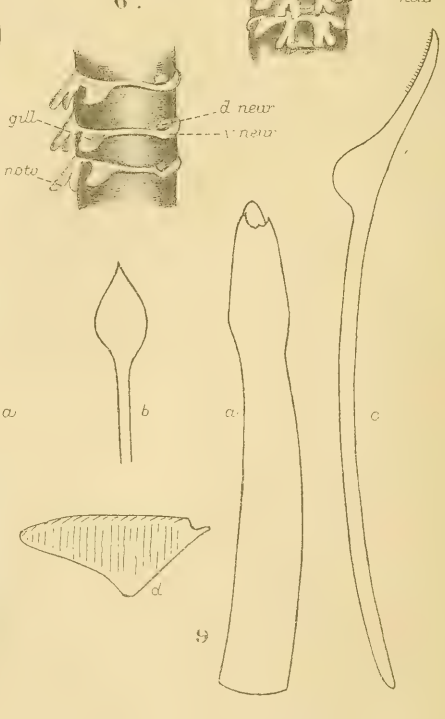
Fig. 1. *Trechalea keyserlingi*, ♀, p. 163.
2. „ „ vulva.
3. „ *urinator*, ♂, tibial spur of palpus, p. 161.
4. „ „ ♀, vulva.
5. „ „ ♂, embolus of palpus.
5*a*. „ „ ♂, „ from below.
6. „ *ellacombei*, ♀, vulva, p. 161.
7. „ *macconnelli*, ♂, tibial spur of palpus, p. 162.
8. „ „ ♂, embolus of palpus.
9. „ *connexa*, ♂, tibial spur of palpus, p. 162.
10. „ „ ♂, embolus of palpus.
11. „ *extensa*, ♂, tibial spur of palpus, p. 162.
12. „ „ ♂, embolus of palpus.
13. „ *longitarsis*, ♂, embolus of palpus, p. 160.
14. „ „ ♂, ditto, apex enlarged.
15. „ „ ♂, tibial spur of palpus.
16. „ „ ♂, ditto, example from Venezuela.
17. „ „ ♀, vulva, example from Colombia.
18. „ *amazonica*, ♂, tibia of palpus and spur, p. 163.
19. „ „ ♂, embolus of palpus.
20. „ „ ♀, vulva.
21. *Hesydrus habilis*, ♂, tibia of palpus and spur, p. 165.
22. „ *palustris*, ♂, tibia of palpus and spur, p. 165.
23. „ „ ♂, embolus of palpus.
24. „ „ ♂, right mandible, from outer side.
25. „ „ ♀, vulva.











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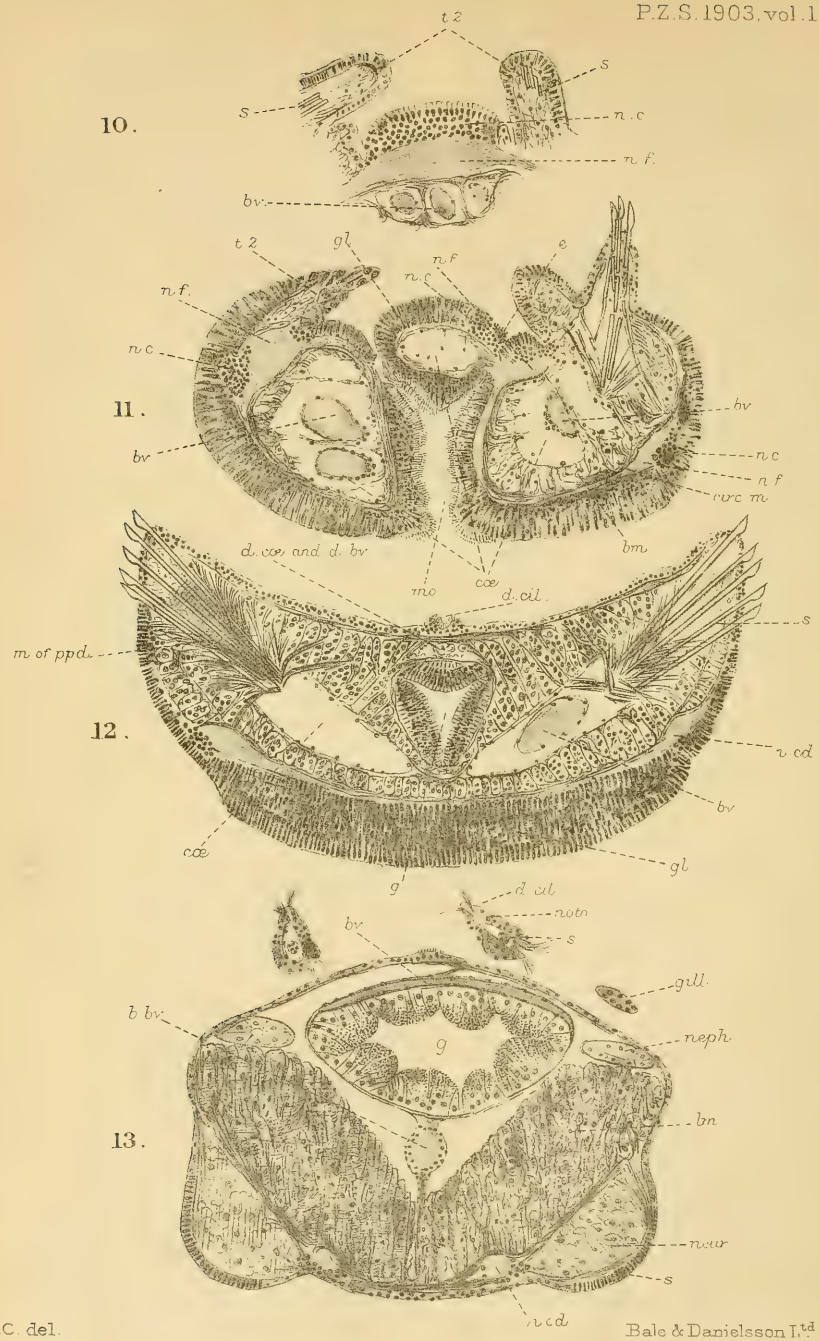
Figs 1, 2, 3, 4, 7, 8. PHYLLOCHLAMYDOPTERUS ? NOTI
„ 5, 6, 9. do. PICTUS.



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PHYLLOCHÆTOPTERUS ELIOTI.

2. On the Marine Fauna of Zanzibar and British East Africa, from Collections made by Cyril Crossland in the Years 1901 and 1902.—Polychæta. Part I. By Cyril Crossland, B.A., B.Sc.[1]

[Received January 15, 1903.]

(Plates XVI. & XVII.[2])

Introduction.

The collections referred to were made under the following circumstances:—Sir Charles Eliot, K.C.M.G., C.B., late Fellow of All Souls College, Oxford, at present H.M. Consul-General at Zanzibar and Commissioner for British East Africa, took me out with him as his private assistant in his researches on Nudibranch Mollusca. I made collections not only of this, but of the other marine groups; accounts of which, by various specialists, will appear in these 'Proceedings' from time to time. The largest collections are those of the Nudibranchiate Mollusca and Polychæte Annelids, of which groups about 150 species in each are to be described. Sir Charles Eliot has already published one part of the results of his examination of the Nudibranchs (P. Z. S. 1902, vol. ii. p. 62); other papers by various authors will shortly be ready.

For the benefit of other possible workers in this region, I may mention that the greater part of my collections was made in two localities, viz. Chuaka Bay, on the east coast of Zanzibar, and Wasin Harbour, near the Anglo-German boundary on the mainland. The former locality is extremely rich in shore forms, and dredging in 3 fathoms of water at the north side of the mouth of the bay was often very productive. Wasin Harbour averages a depth of 10 fathoms, and here I collected almost entirely by dredging. The bottom is extensively covered by a species of *Telesto*, the branches of which are overgrown by an encrusting red sponge. Among this a great variety of the smaller Polychæta and Nudibranchiata are found.

My mention of these two localities is of the more importance to future workers because large stretches of the coast are extremely barren. Unfortunately this applies to the two principal towns of East Africa, and especially to Mombasa. A few miles from Zanzibar, *e. g.* round the islands and sandbanks which surround the harbour, and on one portion of the shore about a mile to the south of the town, *at low spring-tide only*, are rich collecting-grounds, and near this latter area dredging is profitable, especially at a depth of 5 fathoms. The greatest portion of the Zanzibar channel is, however, extremely barren.

More detailed descriptions of the reefs of East Africa, with maps, will be found in my two papers: "On the Coral Reefs of Zanzibar," and "Pemba and British East Africa," in the Proc. Camb. Phil. Soc. vols. xi. & xii. (1902).

[1] Communicated by Prof. W. C. McIntosh, F.Z.S.

[2] For explanation of the Plates, see p. 176.

The gratitude of all zoologists is thus due to Sir Charles Eliot, whose generosity and scientific zeal have enabled these collections, the first of considerable size from this region, to be made. I wish also to express my best thanks to Mr. Stanley Gardiner, who helped me by his advice and in every other possible way, both during my residence in East Africa and in the working out of the collections on my return to England.

Chætopteridæ.

Genus Phyllochætopterus.

The position of the genus *Phyllochætopterus* among the lower Chætopteridæ is shown by the following table of the genera :—

A. Notopodia of the second body-region not foliaceous (*i. e.* two body-regions only)	Ranzania.
B. With foliaceous notopodia posteriorly.	
1. Body divided into two regions	Telepsavus.
2. Body divided into three regions.	
One pair of tentacles	Spiochætopterus.
Two pairs of tentacles	Phyllochætopterus.

The most characteristic feature of the Chætopteridæ is the adaptation of certain parapodia for the production of a respiratory current, which modification, completed in the genus *Chætopterus*, makes the latter one of the most remarkable forms of animal life.

This peculiarity is not developed in *Ranzania*, whose only Chætopterid features are its general build of body, which is divided into an anterior flattened muscular and glandular portion bearing long notopodial setæ only, and a rounder weaker posterior portion with delicate notopodia and neuropodia of uncinigeral tori; in addition it is tubicolous in its mode of life, and procures food by the ciliated grooves of its tentacles and dorsal surface.

To these features are added notopodial gills in *Telepsavus*, in which case they are developed on every segment of the hind-body. In the remaining two genera this modification is restricted to more or fewer of the middle segments, to two only in *Spiochætopterus* and several species of *Phyllochætopterus*, but up to 25 in other species of the latter.

In all the eight species of *Phyllochætopterus* yet known the body is vermiform, the notopodial gills comparatively small and simple, bifid, and containing capillary setæ. All the setæ are characteristically Chætopterid, in the first region long with leaf-like ends, and arranged in a row as in *Chætopterus*, though the notopodia of *P. aciculigerus* alone approach in their long pointed shape those of the former genus. In the fourth notopodium of the first body-region one or more setæ are enlarged and of a dark brown colour, but are not flattened as in *Chætopterus*. The uncini are of one kind only throughout the body, but their form is more specialized than in *Chætopterus*, and is that which occurs in, for example, the Sabellidæ. The parapodia are alike in all the species, differing only in the proportions of the parts, excepting the hind-body notopodia of *P. aciculigerus* (6).

The prostomium is, in this family, usually more or less reduced. In *Chætopterus* itself it is completely merged with the oral funnel, and the same condition is described for some Phyllochætopterids (e. g. *P. claparedi* McIntosh). In all the members of this genus it is normally scarcely distinguishable externally, both pairs of tentacles being carried by the peristomium. In certain specimens of *P. elioti*, however, as described below, it is quite prominent, and so was discoverable in all the four species I have examined.

The first body-region is an almost solid mass of muscular and glandular tissue in all species, but posteriorly musculature is confined to the ventral surface, except at the level of the parapodia, where muscle-bands surround the body. Between these the body-wall is excessively thin dorsally and laterally, and always black from the colour of the gut-walls.

Up to the present six species have been described, viz.:—

P. socialis Claparède. Mediterranean and Atlantic (1) (4).
P. major Claparède. Mediterranean (1).
P. gracilis Langerhans. Canary Islands (2).
P. claparedi McIntosh. Japan (3).
P. aciculigerus Crossland. The Maldive Islands (6).
P. gardineri Crossland. The Maldive Islands (6).

To these I now add:—

P. elioti. Zanzibar.
P. pictus. British East Africa.

Claparède's *P. fallax* was founded on such characters as the numbers of segments composing the three body-regions, the ringing of the tube, &c.; these have been shown by Roule (4) to be variable in members of this genus.

The principal distinctions of systematic importance are:—

(1) Presence or absence of eye-spots, and of the development of the prostomium.
(2) The number of the strong setæ in the notopodium of the fourth setigerous segment.
(3) The proportionate sizes of the parts of the parapodia of the regions B and C.
(4) Ringing and other such details of the tubes are variable, but (1) in some species they are straight and occur singly, and (2) in others they are of a U-shape and occur in numbers twisted together.

These characters are distributed as follows:—

(1) Eye-spots present in *P. socialis*, *P. major*, *P. elioti*, *P. gardineri*, *P. pictus*; absent in *P. claparedi*, *P. aciculigerus*, *P. gracilis*.
(2) A single strong seta in 4th notopodium in *P. socialis*[1], *P. major*, *P. claparedi*, *P. pictus*. More than one seta strengthened. *P. gracilis* with three, *P. gardineri* three, *P. elioti* two, and *P. aciculigerus* eight.

[1] In *P. socialis* two setæ may exceptionally occur, but the extra one is always smaller than the one it accompanies.

(3) The parapodia of the region C consist of double neuropodial tori and a clavate papilliform notopodium containing a single seta in all the species except *P. aciculigerus* and *P. claparedi*.

(4)[1] Tubes straight, occurring singly in *P. claparedi*, *P. elioti*, *P. major*. Twisted together, in numbers, *P. socialis* and *P. pictus*.

PHYLLOCHÆTOPTERUS ELIOTI[2], sp. n. (Plate XVI. figs. 1–3 & 8; Plate XVII. figs. 10–13.)

Of this species numerous specimens occur in Chuaka Bay, Zanzibar. The straight, stiff, opaque black tube, 6 to 9 inches long, is buried in the sand at low tide, one or two inches only projecting. Its presence is usually rendered conspicuous by the growth of a tuft of bright green enteromorpha on the projecting portion.

The colour of the living animal is milk-white anteriorly, and black posteriorly. There is no pigmentation, and the brilliant blue and yellow colours described by Claparède and Lo Bianco in the Naples species are not found in either of the two species I have seen alive. The black colour of the gut gives the usual green solution in alcohol.

The peristomium is very mobile, the whole shape of the head being thus very different in different specimens. When expanded, its shape is as in Pl. XVI. fig. 1. In a few cases only, where the head is much contracted and bent back, does the prostomium and its eye-spots come into view as in fig. 2.

The first pair of tentacles are very slender and long, attaining a length of 9 mm.

The fore-body measures, in a large specimen, 6 mm. in length by 2·5 mm. in breadth, and consists of about 14 setigerous segments. (There were 13 in three specimens, 14 in three more, and 15, 16, and 17 each in three more. The average is thus 14 in nine specimens.) The notopodia are very short and stumpy, but the setæ and their arrangement, as in the other species of the genus, recall *Chætopterus*. The fourth foot has two strong setæ on each side, rarely three on one side or the other, though in one specimen there were three on one side and four on the other. The ordinary setæ are all straight.

The region B (fig. 3) consists of from 20 to 25 segments, the parapodia of which are very like those of *P. gardineri*, except that the notopodial flap is slightly smaller, and there is a long space between it and the ventral portion of the neuropodium, and the parts of this latter are of more nearly equal size. The neuropodium of the first segment of the gill-region is not divided. There are in each notopodium five long setæ whose flexible heads project. The uncini (fig. 8, *c*) are triangular with very fine teeth, just visible under a $\frac{1}{6}$-inch objective.

The hind-body has more than 25 segments, but none of my

[1] The tubes of Gardiner's two species were unfortunately not obtained.

[2] Thus named in honour of Sir Charles Eliot, K.C.M.G., C.B., H.M. Consul-General at Zanzibar, and Commissioner for British East Africa.

specimens are quite complete. The notopodia are the usual clavate papillæ containing a single seta. The neuropodia are as in the gill-bearing region, but much smaller.

The two species *P. elioti* and *P. gardineri* are closely related, differing only in the reduction of the peristomial collar in the latter and the proportions of the mid-body parapodia and setæ.

The only work on the internal anatomy of a member of this genus is the section of the fore-body of *P. claparedi* given by McIntosh, although examination of the anatomy of the species of *Phyllochætopterus* would be extremely interesting, both for comparison among themselves and with the other genera of the family[1], especially *Chætopterus*. Having neither time nor full opportunity for this work, to which my inclinations are most strongly drawn, I can only give here a few deductions from the examination of a series of sections of a specimen of this genus, which appear to differ in many minor details from the above-mentioned section of *P. claparedi*.

Body-wall.—The region A is, as shown by the sections figured (Pl. XVII. figs. 11 & 12), an almost solid mass of glandular and muscular tissue, in marked contrast to the delicacy of the regions B and C. The whole of the ventral epithelium is strongly glandular beyond the limits of the well-marked ventral shield, and these glands extend anteriorly to the dorsal surface and even on to the prostomium. The cuticle is of extreme delicacy, if really present. The musculature consists of weak circular and very strong longitudinal muscles, but the division of the latter into two dorsal and two ventral bundles cannot be made out. In the regions B and C the only muscle occurring dorsally is a very delicate circular layer (Pl. XVII. fig. 13). Diagonal fibres can be traced in the region A between the nerve-cords and the notopodia, which become more definite muscles in the region B (fig. 13).

The *nervous system* is in contact with the skin. The two ventral cords lie at a distance from one another in the region A, but approach one another posteriorly (*cf.* figs. 12 & 13), their arrangement corresponding thus to that in *Chætopterus*. Transverse commissures, portions of one of which are shown in Pl. XVII. fig. 12, connect the two cords.

The brain (Pl. XVII. fig. 10), which in *Chætopterus* is a narrow band dorsal to the mouth, not differentiated from the circum-œsophageal commissures, is here more distinct, in correspondence with the presence of the prostomium in this genus and its absence in the case of *Chætopterus*. It is a perfectly simple swelling of the circum-œsophageal commissures. The continuity of the nervous system with the epidermis is shown by a comparison of the sections of the prostomium given in figs. 10 & 11. The former shows the circumœsophageal connectives, that on the left as it crosses from the ventral to the dorsal side, that on the right, near the eye-spot (*e*) passing into the prostomium. The replacement of the ordinary glandular epithelium of this area by the densely

[1] For anatomy of *Telepsavus*, see pl. xiii. and its explanation in Claparède's 'Annélides Sédentaires.'

staining nerve-nuclei of the brain (which are similar to those seen on the outer side of the ventral nerve-cords &c.) is shown distinctly, this replacement being complete in fig. 10, where the epidermis is composed entirely of nerve-cells.

The eye-spots are a pair of groups of cells, each containing numerous minute granules of black-brown pigment. These are in continuity with the nerve-cells of the brain, but are anterior and dorsal to its fibrous part.

The *cœlom* is small and broken up into several distinct portions. The largest of these are a pair of spaces lying laterally and ventrally to the gut (fig. 12), bounded dorsally by the powerful muscles of the seta-sac. Dorsally and medianly, commencing as a space in the prostomium, is a third part which posteriorly becomes a mere canal surrounding the dorsal blood-vessel. In the region B the cœlom is more normal, though reduced in size. It remains divided into right and left halves by the dorsal and ventral mesenteries of the gut.

The *vascular system* consists of dorsal and ventral vessels, both running in the gut-mesenteries. The former breaks up at the base of the prostomium into three branches (fig. 10), and large connecting-vessels are found in the anterior segments. Posteriorly the dorsal vessel forms a large sinus covering the dorsal wall of the gut (fig. 13).

Alimentary canal.—The mouth is richly ciliated, and the outer ends of its columnar epithelial cells contain a few minute specks of the black-green pigment so characteristic of the family. These are absent from the narrow triangular gut of the region A, but reappear in great quantities in the larger thick-walled alimentary canal of the regions B and C (fig. 13).

The gut-lining here consists of long crowded cells, the swollen distal ends of which are crowded with minute specks of the pigment, indicated by dark dots in the figures.

The transverse sections of the notopodial gills, shown in fig. 13, are interesting. The space which they contain is cœlomic, and at its centre is a bundle of five or six setæ wrapped closely together by fleshy tissue. The transverse section of this resembles that of a telegraph-cable, the wires being represented by the setæ. At each end of the oval section is seen a sharply-cut groove, the sides of which are of granular, rather deeply-staining protoplasm, without nuclei, supporting externally very long cilia. Laterally is a more deeply-stained area of the epithelium, perhaps of nervous function.

PHYLLOCHÆTOPTERUS PICTUS, sp. n. (Plate XVI. fig. 5.)

The tubes of this species are brown and translucent, quite free from sand or mud. They were found clustered together in considerable numbers on the under side of a large stone at low-water level on Pungutiayu islet, Wasin. Each tube has two openings, each limb of the U being about 4·5 cm. long. The bending is irregular, and they are twisted and fused together, so that it is usually almost impossible to separate out any one tube.

The contained worms are the smallest of the species described here, or in (6), being slightly smaller every way than in *P. elioti*.

The specific name refers to the abundance of brown colour found on their tentacles and fore-body. Pigmentation, except of the gut, is rare in the Chætopteridæ. Of the other species, it is described in only two, viz. *P. claparedi* (3) and *P. socialis* (1): in both these it is comparatively slightly developed.

The ground-colour of the anterior region, tentacles, and parapodia of *P. pictus* is, in life, creamy white. The greater part of the posterior regions is, as usual, black, by reason of the pigmentation of the gut.

On either side of the groove which runs along the upper surface of the larger tentacles are regularly arranged squarish blotches of brown, as shown in Pl. XVI. fig. 5. Brown dots are scattered also over the pro- and peristomium and the anterior segments of the fore-body. There are two dark bands with indefinite edges along the ventral bases of the notopodia, and a broad crescent across the ventral surface of the end of the region A.

The mouth is not at all funnel-shaped, but rather slit-like, the two small peristomial lappets coming together from either side. The prostomium is large, flattened from side to side, and projects above the dorsal surface of the fore-body. The very slender second setigerous pair of tentacles lie close on either side of it, being thus very inconspicuous. Two elongated, but distinct, eye-spots, of a dark brown colour, occur one on each side of the prostomium.

The regions A and B consist of the following numbers of segments in different individuals:—

A ...	15	16	—*	13	15	12*	15	13*
B ...	7	9	5	7	5	3	8	—

* These specimens were below the average size.

The fourth notopodium has but one large seta of the shape shown in Pl. XVI. fig. 9, *a*. The bending of this seta is remarkable as occurring only in this species. Its three teeth, when seen from one point of view, give an explanation of Langerhans's figure of the corresponding seta in *P. gracilis*, which is not otherwise intelligible.

The other setæ are all straight, and present no peculiarities except those of the last notopodium, which are bent, and the head is finely toothed (fig. 9, *c*).

The parapodia of the region B (figs. 5 & 6) are small, the neuropodial ridges especially so. In correspondence with this the uncini are very minute and delicate (·03 mm. long), and their teeth barely visible under a $\frac{1}{6}$-inch objective (fig. 9, *d*). The neuropodia do not extend far up the side of the body, and the space between them and the notopodial gills is not filled up by the triangular membranous gill-flap as in the other species (fig. 6). The notopodia contain two or three thin setæ which do not project.

In the region C the notopodia are reduced to little clavate papillæ, containing one seta, as in all the other species except

P. claparedi and *P. aciculigerus* (see fig. 6, of *P. elioti*). The neuropodia also are small.

List of the Literature.

(1) Claparède.—Annélides du Golfe de Naples, 1868.
(2) Langerhans.—"Ueber einige Canarischen Anneliden." Nov. Act. der Leop.-Carol. Deutschen Akad. Bd. xliii., 1881.
(3) McIntosh.—'Challenger' Reports, vol. xii., 1885, p. 374.
(4) Roule.—"Campagne du Caudan." Ann. d. l'Université de Lyon, 1896.
(5) Lo Bianco.—Ann. Tub. nel Golfo di Napoli, 1893.
(6) Crossland.—J. Stanley Gardiner's 'Fauna and Geography of the Maldive Archipelago.' In the press.

EXPLANATION OF THE PLATES.

Plate XVI.

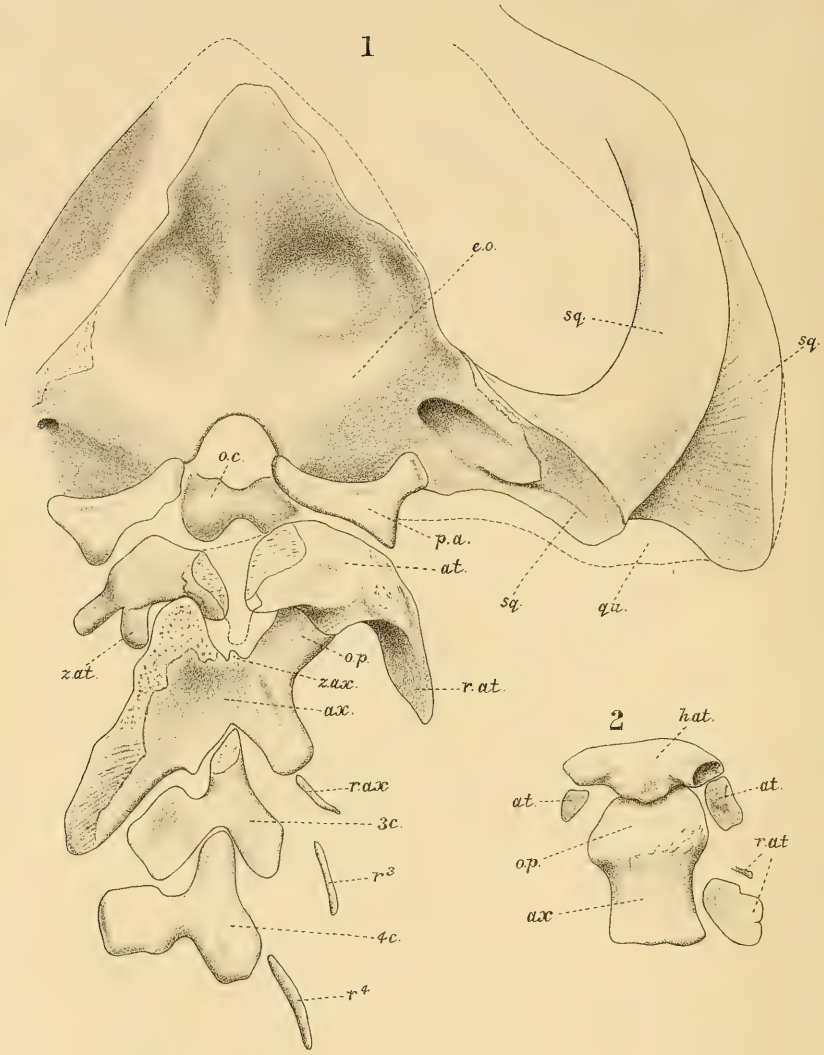
Fig. 1. Normal condition of the head of *Phyllochætopterus elioti* (p. 172), as seen from dorsal side. × 10.
2. Side view of a specimen whose prostomium and eye-spots are visible. × 10.
3. Side view of three segments of the region B. × 10.
4. Ventral view of the same.
5. *P. pictus* (p. 174). Dorsal view of anterior part of body. × 10.
6. Side view of three segments of the region B. × 10.
7. A notopodium of the region C in either species. × 100.
8. Setæ of *P. elioti* (p. 172).
   (*a*) Thickened seta of fourth parapodium. × 83.
   (*b*) Normal seta from third foot. × 90.
   (*c*) An uncinus. × 1000.
9. Setæ of *P. pictus* (p. 172).
   (*a*) Thickened seta from the fourth foot. × 100.
   (*b*) Head of a normal seta from the same bunch. × 200.
   (*c*) From last foot of region A. The shaft is bent and part of the head finely toothed. × 100.
   (*d*) One of the uncini. × 1000.

Plate XVII.

Fig. 10. Section of *Phyllochætopterus elioti* (p. 172) through the brain, bases of short tentacles, &c.
11. Section a little anterior to fig. 10, through mouth, first feet, &c.
12. Section at level of fifth foot.
13. Section near beginning of region B. All sections × 42.

The meaning of the lettering on the figures of the Plates is as follows:—

b.v.=blood-vessel.
circ.m.=circular muscle.
cœ.=cœlum.
d.bv.=dorsal blood-vessel.
d.cil.=dorsal ciliated groove.
d.cœ.=dorsal division of cœlom.
d.neur.=dorsal division of the neuropodia.
e.=eye.
g.=gut.
gill.=gill-flap between noto- and neuropodia.
gl.=glandular areas or epithelia &c.
lm.=longitudinal muscle-layer.
m.=muscle.
mo.=mouth.
m. of ppd.=muscles of parapodium.
n.=nerve.
n.c.=nerve-cells.
n.cd.=nerve-cord.
n.f.=nerve-fibres.
neph.=nephridium.
neur.=neuropodium or ventral division of the foot.
noto.=notopodium or dorsal division of the foot.
peri.=peristomium.
ppd.=parapodium or foot.
pro.=prostomium.
s.=seta.
t_1 & t_2=first and second pairs of tentacles.
v.bv.=ventral blood-vessel.
v.neur.=ventral division of the neuropodia.



R. Broom del.
M. P. Parker lith.

Parker & West imp.

AXIS, ATLAS, & PROATLAS OF
GOMPHOGNATHUS & TRIRACHODON.

3. On the Axis, Atlas, and Proatlas in the Higher Theriodonts. By R. Broom, M.D., B.Sc., C.M.Z.S.

[Received January 20, 1903.]

(Plate XVIII.[1])

Hitherto, though something has been known of the structure of the axis in at least two of the Dicynodonts and in *Cynognathus*, we have been practically ignorant of the structure of the atlas in any of the Theriodonts or Anomodonts. In fact, Prof. Seeley (1) in describing the axis of *Cynognathus*, seems to be in doubt whether he is really dealing with an axis, or with an axis and atlas combined. On page 100 of his paper he says, "The first vertebra appears to be anchylosed to the second"; while a little further on he states that "this vertebra is remarkable for its form being exactly like the odontoid process of the vertebra in many animals, and suggesting the idea that the atlas is lost"; and in a note he adds: "This appears to be confirmed by the subsequently to be described condition in *Tropidostoma dunni*." In counting the vertebræ, however, he counts the axis as the 1st cervical, and states that "there are 6 cervicals." Gadow (2), in his recently published work on Reptiles, possibly misled by Seeley, definitely states that "the atlas is fused with the axis." Considering how mammal-like the higher Theriodonts are, and that the axis bears a very marked resemblance to the mammalian axis, having a large spine and a well-developed odontoid process, it seems remarkable that the idea should have arisen that the atlas was anchylosed to the axis, more especially as there is no part of the axis in *Cynognathus* that bears any resemblance to any known atlas.

When in Grahamstown recently, I had an opportunity, through the kindness of Dr. Schönland, of examining the Theriodonts in the Albany Museum, and especially the very fine specimens of *Gomphognathus* and *Trirachodon*, which have been described by Seeley (3), and which have been so marvellously developed under his direction. In both the type specimens of *Gomphognathus kannemeyeri* and *Trirachodon kannemeyeri* the anterior cervical vertebræ are most beautifully shown, but Seeley in his description of the specimens makes no reference to this most important region, beyond stating (p. 53) that "the occipital plate [in *Trirachodon*] is not completely exposed owing to some of the vertebræ being in contact." Two of his figures of the skull of *Trirachodon* show the atlas and part of the axis; but as no distinction is shown between matrix and bone, it is difficult to make anything of the drawing.

The beautiful specimen which forms the type of *Gomphognathus*

[1] For explanation of the Plate, see p. 180.

consists of two complete mandibles in articulation with the posterior half of the skull. The lower jaw lies almost at right angles to the axis of the skull, and the upper cervical vertebræ have been to some extent protected by passing down between the two rami. The skull consists of the practically complete occiput with both temporal arches in almost perfect condition, and with most of the parietal and sphenoidal regions well shown. Though the sutures unfortunately are not distinct, the occiput is so well preserved, practically without distortion, that I think it worthy of being figured.

The vertebræ so far as preserved consist of the proatlas, atlas, axis, and the 3rd and 4th cervical vertebræ.

The atlas (*at.*) consists of a well-developed arch and a distinct hypapophysis (*h.at.*). The arch is partly broken in the middle, but must have borne considerable resemblance to that of the mammals. It differs in having had a distinct posterior zygapophysis (*z.at.*) for articulation with the small anterior zygapophysis of the axis (*z.ax.*). The zygapophysis of the left side is well preserved, but that of the right has been broken off. On the right side the outer part of the arch is continued backwards as a well-developed bony process or rib (*r.at.*). It is probable that the process is really a rib, but I have been unable to find a suture between it and the arch. On the under surface, what appears to be part of the rib of the left side is seen lying by the side of the body of the axis (*r.at.*). The well-developed hypapophysis is also well seen. It appears to have had only a ligamentous connection with the arch of the atlas.

In front of the arch of the atlas, and lying in the hollows formed above and outside of the occipital condyles, are the two portions of the proatlas. Each consists of a short bony arch with a well-developed process passing upward and outward from its outer end.

The axis is well developed, and bears considerable resemblance to that of *Cynognathus*. The spine forms a very large flattened crest. In the specimen it is somewhat damaged, but there is probably not a great deal missing. In front, the spine passes forwards over the arch of the atlas, and possibly forms an articulation with it as in the Monotremes. Between the anterior part of the spine and the odontoid process is the small anterior zygapophysis (*z.ax.*). The odontoid process (*o.p.*) is well developed, and on the right side it is seen articulating with the arch of the atlas. On the under surface the body of the axis is seen, as also a part of the odontoid process in articulation with the hypophysis of the atlas. On the upper surface, near the posterior end of the centrum, on the right side is a portion of the rib of the axis.

The 3rd and 4th cervicals present no features worthy of any special remark. Remains of ribs are seen in connection with each.

In the type specimen of *Trirachodon kannemeyeri* there are preserved and well shown the two portions of the proatlas, the

arch and hypapophysis of the atlas, and the odontoid process and part of the body of the axis. Though the structure of the vertebræ is essentially similar to that in *Gomphognathus* there are many points of difference.

The proatlas (*p.a.*), though occupying the same relative position as in *Gomphognathus*, is less specialized. It is present as a pair of curved, moderately thin, bony plates lying in front of, and probably somewhat overlapping, the arch of the atlas. There is no bony process developed as in *Gomphognathus*.

The atlas (*at.*) consists of a well-developed arch and a distinct hypapophysis. The arch is not so complete as in *Gomphognathus*, and must have differed considerably in regard to the arrangement of the anterior articular surfaces. In *Gomphognathus* the occipital condyles (*o.c.*) are small and moderately close together, whereas in *Triarhodon* the condyles (*o.c.*) are very large and as wide as the atlas. The arch, perhaps on this account, does not close in inferiorly to meet the hypapophysis, with which it can only have been attached by ligament. The zygapophysis (*z.at.*) for the axis is very small. The hypapophysis (*h.at.*) is very similar to that in *Gomphognathus*.

Of the axis only the odontoid process, imperfectly displayed, and a part of the body remain.

The structure of the upper cervical vertebræ is so imperfectly known in the majority of fossil reptiles, that there is some difficulty in satisfactorily dealing with the affinities of the structures. It is difficult to avoid being struck by the close resemblance of the axis, atlas, and proatlas in the Theriodont to those structures in the Crocodiles, more especially as there is no close affinity between the groups. The explanation is probably to be found in the fact that both the Crocodiles and the Theriodonts, though far removed from each other, have retained with but slight modification the type of structures met with in their common ancestor. In *Sphenodon*, though the proatlas is small, the type is practically the same; and I have recently discovered that *Procolophon* has a well-developed proatlas. *Procolophon* has usually hitherto been associated with the Dicynodonts, Theriodonts, and Pareiasaurians, but as it has a persistent notochord, abdominal ribs, a plate-like pubis and ischium, and 2, 3, 4, 5, and 4 phalanges in the digits, it is manifestly much more closely related to *Palæohatteria* than it is to the Theriodonts and Dicynodonts. In most of its structures it is probably as primitive as the common ancestor of the Crocodiles and Theriodonts, so that there is good reason for believing that the common ancestor had a well-developed proatlas and probably an atlas and axis very similar to those found in later forms, but almost certainly with the odontoid process as a distinct element, as seen in *Ichthyosaurus*. No proatlas has yet been detected in *Pareiasaurus*, but I have found one in *Lystrosaurus* (= *Ptychognathus* Owen). It will probably yet be found in most of the primitive reptilian types.

Works referred to.

(1) H. G. Seeley: "On the Skeleton in new Cynodontia from the Karroo Rocks." Phil. Trans. vol. 186 B. p. 59 (1896).
(2) H. Gadow: 'Amphibia and Reptiles.' London, 1901.
(3) H. G. Seeley: "On the Gomphodontia." Phil. Trans. vol. 186 B. p. 1 (1896).

EXPLANATION OF PLATE XVIII.

Fig. 1. Occiput and upper cervical vertebræ of *Gomphognathus kannemeyeri*. Nat. size.
Fig. 2. Under view of atlas and axis of *Gomphognathus*. Nat. size.
Fig. 3. Posterior view of atlas &c. of *Trirachodon kannemeyeri*. Nat. size.
Fig. 4. Under „ „ „ „ „ Nat. size.
Fig. 5. Side „ „ „ „ „ Nat. size.

at., atlas; *ax.*, axis; *e.o.*, exoccipital; *h.at.*, hypapophysis of atlas; *o.c.*, occipital condyle; *o.p.*, odontoid process; *p.a.*, proatlas; r^3, r^4, ribs; *r.at.*, atlas rib; *r.ax.*, axis rib; *sq.*, squamosal; *z.at.*, zygapophysis of atlas; *z.ax.*, zygapophysis of axis; 3*c*, 4*c*, 3rd and 4th cervical vertebræ.

4. A Revision of the Fishes of the Genus *Triacanthus*. By C. Tate Regan, B.A.[1]

[Received January 20, 1903.]

Although six species of *Triacanthus* were described and figured by Bleeker in the 'Atlas Ichthyologique,' Günther, in his Catalogue, recognized only three (viz.: *Tr. strigilifer* Cantor, *biaculeatus* Bloch, and *brevirostris* Schlegel), and did not accept either of the four described by Dr. Bleeker as new, but placed three of them (viz.: *Tr. macrurus*, *blochi*, and *oxycephalus*) in the synonymy of *Tr. biaculeatus*, and the fourth (*Tr. nieuhofi*) in that of *Tr. brevirostris*. Since then this arrangement has not been challenged, nor has any new species of this genus been described.

Subsequent to the reading of my paper on the Plectognathi[2], I examined the specimens of *Triacanthi* in the British Museum Collection, which include Bleeker's types, and I have come to the conclusion that all six species described by Bleeker are valid, although the one he called *Tr. macrurus* is certainly identical with *Tr. biaculeatus* Bl., a species not recognized by him; whilst a seventh species, which has been generally confused with *Tr. brevirostris* Schleg., is now described for the first time as *Tr. indicus*. A complete revision of the synonymy has thus become necessary, and the need for more complete diagnoses of the various species is obvious. In the descriptions given below, which are in each case based on several specimens, the total length is measured to the base of the first caudal ray, the length of head to the gill-opening, the length of the caudal peduncle from the base of the last dorsal to that of the first caudal ray, the length of the snout from its tip to the vertical from the anterior margin of the eye, that of the

[1] Communicated by G. A. Boulenger, F.R.S., V.P.Z.S.
[2] P. Z. S. 1902, ii. p. 284.

postorbital part of the head from the vertical from the posterior margin of the eye to the gill-opening. Young specimens have a shorter snout, a deeper body, and longer dorsal and ventral spines than adults, and have been excluded from the diagnoses. In each case the total length of the largest example here described is given.

Triacanthus Cuvier.

Body compressed, covered with small rough scales; caudal peduncle more or less elongate, tapering; mouth small; teeth in 2 series in each jaw, 10 in each outer series, incisor-like; those of the inner series obtuse, rounded, 6 in the upper jaw, 2 in the lower. Branchiostegals 6; pseudobranchiæ present. Spinous dorsal with 5 rays, the first a long and strong spine; soft dorsal with 20–25 rays; anal with 15–20 rays; ventral fins each represented by a strong spine, without soft rays; caudal widely forked. Vertebræ 20.

In all the species the colour is strikingly similar, being bluish grey above, silvery below. The only tangible differences in colour are that the membrane of the spinous dorsal fin is in some specimens immaculate, in others wholly or partly blackish.

Key to the Species.

I. Second ray of spinous dorsal more than half as long as the first, membrane of spinous dorsal immaculate; length of base of anal half that of soft dorsal; D. V, 20–22; A. 15–16 ..... 1. *Tr. strigilifer* Cantor.

II. Second ray of spinous dorsal less than half as long as the first.

A. Snout concave; pelvis between ventral spines tapering to a distinct point posteriorly.

a. Membrane of spinous dorsal immaculate; length of caudal peduncle $4\frac{1}{2}$–$5\frac{1}{4}$ times in total length; length of base of anal $1\frac{3}{4}$–$1\frac{4}{5}$ times in that of soft dorsal; D. V, 22–23; A. 16–17 ..... 2. *Tr. blochi* Bleeker.

b. Membrane between first two rays of spinous dorsal blackish; length of caudal peduncle $4\frac{1}{2}$–5 times in total length; length of base of anal $1\frac{2}{3}$–$1\frac{3}{5}$ times in that of soft dorsal; D. V, 23–24; A. 18–19 ..... 3. *Tr. biaculeatus* Bloch.

c. Membrane of spinous dorsal immaculate; length of caudal peduncle $6\frac{1}{2}$–7 times in total length; length of base of anal $1\frac{2}{5}$–$1\frac{3}{4}$ times in that of soft dorsal; D. V, 24–25; A. 17–19 ..... 4. *Tr. oxycephalus* Bleeker.

B. Snout straight; pelvis between ventral spines scarcely narrowed posteriorly; D. V, 24–25; A. 18–20.

a. Membrane of spinous dorsal blackish; snout half as long as the head; postorbital part of head not shorter than eye-diameter ..... 5. *Tr. brevirostris* Schlegel.

b. Membrane of spinous dorsal blackish; snout more than half as long as the head; postorbital part of head shorter than eye-diameter. 6. *Tr. indicus*, n. sp.

c. Membrane between first two rays of spinous dorsal blackish; snout less than half as long as the head; postorbital part of head shorter than eye-diameter ..... 7. *Tr. nieuhofi* Bleeker.

Triacanthus strigilifer.

Triacanthus strigilifer Cantor, Mal. Fish. p. 363, pl. ix. (1847); Bleeker, Atlas Ichth. v. p. 89, pl. ccxxix. fig. 3 (1865); Günther, Cat. viii. p. 211 (1870).

Triacanthus longirostris Hollard, Ann. Sci. Nat. (4) i. 1854, p. 46, pl. ii. fig. 3.

Depth of body about equal to the length of head, about 3 times in the total length, length of caudal peduncle $4\frac{1}{2}$–5 times. Snout very slightly concave, its length $1\frac{3}{5}$–$1\frac{3}{4}$ times in that of the head, eye-diameter 3–4 times, interorbital width 4–5 times. Interorbital space concave, without distinct median ridge. Upper edge of occipital crest in the same straight line as that of the snout; distance to base of first dorsal spine from posterior margin of eye about $1\frac{1}{2}$ times the eye-diameter. D. V, 20–22; A. 15–16; the first dorsal spine longer than the head, the second considerably more than half as long as the first, the others much shorter; the base of the anal fin about half as long as that of the soft dorsal fin; pelvis between the ventral spines moderately broad, tapering to a point posteriorly. Membrane of spinous dorsal immaculate.

Total length 185 mm.

Hab. Seas of Arabia and India; East Indian Archipelago.

Triacanthus blochi.

Triacanthus blochi Bleeker, Nat. Tijds. Ned. Ind. iii. 1852, p. 81; Atlas Ichth. v. p. 89, pl. ccxvii. fig. 1 (1865).

Triacanthus biaculeatus (part.) Günther, Cat. viii. p. 210 (1870).

Depth of body about 3 times in the total length, length of head $3\frac{1}{2}$–$3\frac{4}{5}$ times, length of caudal peduncle $4\frac{1}{2}$–$5\frac{1}{4}$ times. Snout concave, its length $1\frac{4}{5}$–2 times in the length of head, eye-diameter 3–$3\frac{3}{4}$ times, interorbital width 4–5 times. Interorbital space concave, with median ridge scarcely, if at all, distinct. Upper edge of occipital crest forming an angle of about 160° with that of the snout; distance from posterior margin of eye to base of first dorsal spine about $1\frac{1}{4}$ times as long as the eye-diameter. D. V, 22–23; A. 16–17; the first dorsal spine longer than the head, the others short; length of base of anal fin $1\frac{3}{4}$–$1\frac{4}{5}$ times in that of the base of soft dorsal fin. Pelvis between ventral spines narrow, tapering to a slender point. Membrane of spinous dorsal immaculate.

Total length 150 mm.

Hab. East Indian Archipelago; China.

Triacanthus biaculeatus.

Balistes biaculeatus Bloch, Ausl. Fische, pl. 148. fig. 2 (1785).

Triacanthus biaculeatus Cuv. Règne An. ii. p. 152 (1817).

Triacanthus angustifrons Hollard, Ann. Sci. Nat. (4) i. 1854, p. 45, pl. ii. fig. 2.

Triacanthus macrurus Bleeker, Atlas Ichth. v. p. 91, pl. ccxxii. fig. 3 (1865).

Triacanthus biaculeatus (part.) Günther, Cat. viii. p. 210 (1870).

Depth of body about $2\frac{4}{5}$ times in the total length, length of head about $3\frac{1}{2}$ times, length of caudal peduncle $4\frac{1}{2}$–5 times. Snout concave, its length $1\frac{3}{5}$–$1\frac{4}{5}$ times in the length of head, eye-diameter $3\frac{1}{2}$–4 times, interorbital width 4–5 times. Interorbital space concave, with median ridge scarcely, if at all, distinct. Upper margin of occipital crest forming an angle of about 170° with that of the snout; distance from posterior margin of eye to base of first dorsal spine $1\frac{2}{5}$–$1\frac{3}{5}$ times as long as the eye-diameter. D. V, 23–24; A. 18–19; the first dorsal spine longer than the head, the others short; length of base of anal fin $1\frac{2}{5}$–$1\frac{3}{5}$ times in that of the base of the soft dorsal fin; pelvis between ventral spines rather narrow, tapering posteriorly to a slender point. Membrane between first and second rays of spinous dorsal fin blackish.

Total length 180 mm.

Hab. East Indian Archipelago; Australia; China.

Triacanthus oxycephalus.

Triacanthus oxycephalus Bleeker, Verh. Bat. Gen. xxiv. 1852, p. 27, pl. v. fig. 10; Atlas Ichth. v. p. 90, pl. ccxx. fig. 3 (1865).

Triacanthus biaculeatus (part.) Günther, Cat. viii. p. 210 (1870).

Depth of body $2\frac{1}{3}$–$2\frac{1}{2}$ times in total length, length of head about 3 times, length of caudal peduncle $6\frac{1}{3}$–7 times. Snout slightly concave, its length about $1\frac{4}{5}$ times in the length of head, eye-diameter 3–4 times, interorbital width 3–$3\frac{1}{4}$ times. Interorbital space flat. Upper edge of occipital crest convex; distance from posterior margin of orbit to base of first dorsal spine about $1\frac{3}{4}$ times as long as the eye-diameter. D. V, 24–25; A. 17–19; first dorsal spine longer than the head, the others short; length of base of anal fin $1\frac{3}{5}$–$1\frac{3}{4}$ times in that of the base of the soft dorsal fin; pelvis between the ventral spines broad anteriorly, tapering to a point posteriorly. Membrane of spinous dorsal fin immaculate.

Total length 140 mm.

Hab. East Indian Archipelago.

Triacanthus brevirostris.

Triacanthus brevirostris Schlegel, Faun. Japon., Poiss. p. 294, pl. cxxix. fig. 2 (1846); Bleeker, Atlas Ichth. p. 94, pl. ccxxxi. fig. 3 (1865); Günther, Cat. viii. p. 209, part. (1870).

Triacanthus biaculeatus Bleeker, Verh. Bat. Gen. xxii. 1849, p. 6.

Triacanthus rhodopterus Bleeker, Verh. Bat. Gen. xxiv. 1852, p. 25, pl. iv. fig. 8.

Triacanthus russellii Bleeker, t. c. p. 25.

Depth of body $2\frac{1}{2}$–$2\frac{3}{4}$ times in the total length, length of head $3\frac{1}{4}$–$3\frac{3}{4}$ times, length of caudal peduncle $4\frac{3}{4}$–$5\frac{1}{2}$ times. Snout straight, its length about twice in that of the head, eye-diameter $3\frac{1}{2}$–5 times, interorbital width about $3\frac{1}{5}$ times. Length of post-

orbital part of head equal to or greater than eye-diameter. Interorbital space with a more or less distinct median ridge, with a groove on each side of it. Occipital crest convex, moderately elevated, becoming nearly horizontal in front of the base of the first dorsal spine. D. V, 24–25; A. 18–20; first dorsal spine shorter than the head, the others short; length of base of anal fin $1\frac{2}{5}$–$1\frac{3}{5}$ times in that of soft dorsal fin; pelvis between ventral spines broad, scarcely narrowed posteriorly. Membrane of spinous dorsal fin blackish.

Total length 250 mm.

Hab. East Indian Archipelago, Seas of China and Japan.

TRIACANTHUS INDICUS, n. sp.

Russell, Indian Fishes, p. 14, pl. xxi. (1803).

Balistes biaculeatus Bennett, Fishes of Ceylon, pl. xv. (1830).

Triacanthus biaculeatus Cantor, Mal. Fish. p. 360 (1847); Day, Fishes of Malabar, p. 260 (1865).

Triacanthus brevirostris Hollard, Ann. Sci. Nat. (4) i. 1854, p. 45, pl. ii. fig. 1; Günther, Cat. viii. p. 209, part. (1870); Day, Fishes of India, p. 685, pl. clxxv. fig. 1 (1878).

Depth of body $2\frac{1}{3}$–$2\frac{2}{3}$ times in the total length, length of head $3\frac{1}{4}$–$3\frac{1}{2}$ times, length of caudal peduncle $4\frac{1}{4}$–5 times. Snout straight, its length about $1\frac{3}{4}$ times in that of the head, eye-diameter $3\frac{1}{4}$–$4\frac{1}{4}$ times, interorbital width 3–$3\frac{3}{4}$ times. Length of postorbital part of head distinctly less than eye-diameter. Interorbital space with a more or less distinct median ridge with a groove on each side of it. Occipital crest elevated, its upper edge nearly in the same straight line with that of the snout. D. V, 24–25; A. 18–20; first dorsal spine nearly as long as the head, the others short; length of base of anal fin $1\frac{1}{3}$–$1\frac{1}{2}$ times in that of soft dorsal fin; pelvis between ventral spines broad, scarcely narrowed posteriorly. Membrane of spinous dorsal fin blackish.

Total length 220 mm.

Hab. Coasts of India from Kurrachee to Penang; Ceylon; Andaman Is.

This species differs from *T. brevirostris* chiefly in the longer snout, the shorter postorbital part of head, and the shorter and more elevated occipital crest. The figures given by Russell and Bennett are excellent.

TRIACANTHUS NIEUHOFI.

[1] Nieuhof, Gedenkw. Zee en lantr. p. 272, fig.

Willoughby, Ichthyology, Appendix, p. 5, pl. x. fig. 2 (1686).

? Gronow, Mus. i. p. 52 (1754–6) & Zoophyl. p. 53 (1763–81).

Triacanthus nieuhofi Bleeker, Verh. Bat. Gen. xxiv. 1852, p. 26, pl. iv. fig. 9, & Atlas Ichth. v. p. 92, pl. ccxvii. fig. 3 (1865).

Triacanthus brachysoma Bleeker, Nat. Tijds. Ned. Ind. iv. 1853, p. 128.

[1] I have not been able to verify this reference.

? *Balistes bipes* Gronow, Cat. Fish. p. 37 (1854).

Triacanthus brevirostris (part.) Günther, Cat. viii. p. 209 (1870).

Depth of body about $2\frac{1}{3}$ times in the total length, length of head $3\frac{1}{2}$–$3\frac{2}{5}$ times, length of caudal peduncle $4\frac{1}{3}$–$4\frac{1}{4}$ times. Snout straight, about $2\frac{1}{5}$ times in the length of head; eye-diameter about $3\frac{1}{4}$ times and equal to interorbital width. Length of postorbital part of head less than eye-diameter. Interorbital space with median ridge with a groove on each side of it; occipital crest strongly elevated, the distance from the base of first dorsal spine to the upper angle of gill-opening rather more than the distance from the base of the first dorsal spine to the anterior margin of eye. D. V, 24–25; A. 18–20; first dorsal spine longer than the head, the others short; length of base of anal fin about $1\frac{1}{2}$ times in that of the base of soft dorsal fin; pelvis between the ventral spines broad, not much narrowed posteriorly; membrane between first two rays of spinous dorsal fin blackish.

Total length 126 mm.

Hab. East Indian Archipelago.

This species has a shorter and more declivous snout than *Tr. brevirostris*, and also occipital crest more elevated, postorbital part of head shorter and body deeper.

5. On the Geographical Variations of the Sand-Viper, *Vipera ammodytes*. By G. A. Boulenger, F.R.S., V.P.Z.S.

[Received January 30, 1903.]

(Text-figures 27 & 28.)

The variations of *Vipera ammodytes* in connection with the distribution of the species have not received sufficient attention. Having succeeded in bringing together and carefully comparing a series of 55 specimens from various localities, I have convinced myself that the South-eastern specimens (Greece, Archipelago, Syria) can be distinguished from the typical form from Austria-Hungary, Dalmatia, Bosnia, and Montenegro, not by means of any single absolute character, but by a combination of characters, as shown by the following definitions:—

Forma typica (text-fig. 27 *a*).—Naso-rostral shield usually [1] reaching the canthus rostralis, and extending considerably higher up than the upper border of the rostral, which is usually broader than deep (text-fig. 28 *a*); rostral "horn" with 3 (rarely 2 or 4) transverse series of scales between the rostral shield and the apex. Ventral shields 145 to 163. The dark shade on the lower lip, if present, broken up by light bars separated by 2 to 4 labial shields. Lower surface of end of tail usually red [2]. Grows to 80 centimetres.

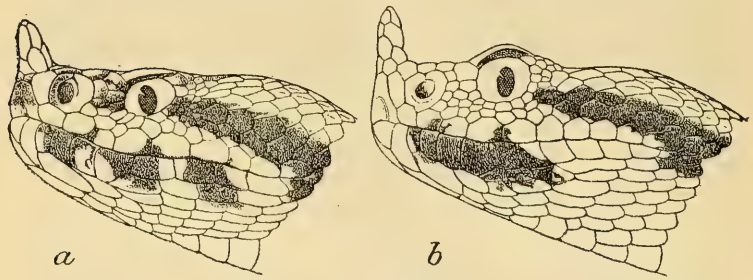
Var. *meridionalis* (text-fig. 27 *b*).—Naso-rostral shield never

[1] 5 exceptions out of 30 specimens examined

[2] Yellow in one specimen from the Dinaric Alps, Bosnia.

reaching the canthus rostralis, and but rarely extending higher up than the upper border of the rostral, which is often as deep as broad or a little deeper than broad (text-fig. 28 *b*); rostral "horn" with 3 to 5 transverse series of scales between the rostral shield and the apex. Supraciliary edge usually more prominent than in the typical form, sometimes slightly angular, foreshadowing the condition in *V. raddii*. Ventral shields 133 to 147. A more or less distinct dark blotch on the lower lip, involving 5 or 6 labial shields without interruption. Lower surface of end of tail yellow. Grows to 60 centimetres.

Text-fig. 27.



Side views of heads of *a*, *Vipera ammodytes*, f. *typica* (Feldkirchen, Carinthia), and *b*, var. *meridionalis* (Athens).

Text-fig. 28.

Front view of end of snout, showing the lepidosis.
a. Feldkirchen, Carinthia; *b*. Athens; *c*. Cocosu, Roumania.

I submit these definitions to the consideration of herpetologists who may have the privilege of examining large series of specimens from any single district. The material at my command is still deficient in examples from Bulgaria, Turkey, and the Caucasus, and I may mention that the only two specimens from Roumania which I have been able to examine differ from both forms as here characterized, and are on the whole intermediate between them. The rostral shield is deeper than broad, and the naso-rostral does not reach the canthus rostralis (text-fig. 28 *c*); one has two series of scales on the rostral "horn," the other has three; supraciliary edge not very prominent; ventral shields 155 and 153; no light bars on the lower lip; lower surface of tail yellow.

6. Notes on the Habits of the Hoolock.

By Geo. Candler, M.B.Cantab.[1]

[Received January 20, 1903.]

The Hoolock (*Hylobates hoolock*) is one of the most interesting of the family Simiidæ, and is perhaps not so familiar to naturalists at home as are some other members of the family, as, owing to its extreme delicacy and the great difficulty experienced in keeping it alive in confinement, it does not often find its way into European collections. Even in the Calcutta Zoological Gardens it is difficult to keep Hoolocks alive for any length of time. They often succumb to pneumonia, or if they escape actual disease they mope and die from the effects of confinement, or possibly from deprivation of some article of diet which in the wild state they have been accustomed to. I have ventured therefore to submit to the Society these short notes, made from the point of view of a field-naturalist rather than from a scientific aspect.

The Hoolock is clothed all over with a fine soft hair, which, perfectly black in the male, in the female shows a greyish tint, especially over the back. This uniform dark colour is only relieved by narrow horizontal streaks of white hair above the eyes. The face, palms of the hands, and soles of the feet are devoid of hair, and here the black skin is smooth and finely wrinkled and as soft as the finest kid.

The hallux and pollex have a flattened nail, the remaining digits have the nail laterally compressed and resembling a claw.

There is no tail. Ischial tuberosities and cheek-pouches are absent.

When the Ape is sitting, the vertebral column presents a single marked curve with the convexity backwards. On the ground the Hoolock has a very characteristic gait. He goes along in a sort of shambling waddle, with legs bowed and knees bent, the soles of his feet applied flat to the ground with the hallux widely abducted, both arms being carried upwards and extremely abducted as if to balance himself. He cannot get up any speed, and invariably swings up into the first tree he comes to, where his movements are suddenly changed from extreme awkwardness to extraordinary grace and agility.

He swings along to the thinnest part of a bough, or to the slender end of a bamboo, until it bends to his weight, then with a swing and a sort of a kick-off he flies through the air, seizing another bough and swinging along it with the unerring accuracy of a finished trapeze performer. I fancy he does very little walking in the wild state, for I have never seen a wild Hoolock on the ground. Moreover, they are only found in the dense jungle where the ground is everywhere covered by tangled vegetation. It is puzzling to me why these anthropoids, being so entirely arboreal

[1] Communicated by F. G. Parsons, F.Z.S.

in habit, should be lacking in such a useful appendage as a tail. I think, at any rate, that it points to the fact that the apes have been developed along a line distinct from the monkeys, the earlier traces of which line are yet to be discovered.

The Hoolocks are extremely shy, and it is most difficult to watch them, as they are concealed by leaves high up in the tops of the bamboo-clumps or forest trees. You may hear their cries all round you as you ride quickly along a jungle-tract, but the moment you leave the path or look up at them there is a dead silence and scarcely a leaf stirs, until, tired of waiting, you move on again.

The cry of the Hoolock is a characteristic sound in the Cachar jungle. It is a very pleasing note, rising and falling in intensity, and reminding one somewhat in its rhythm of a pack of beagles giving tongue on a scent which is waxing and waning in strength, as a larger or smaller number of the band join in the chorus. It is heard chiefly in the early morning, then all through the heat of the day there is silence, but towards evening, as the sun sinks, you may hear it again. Hooloo! Hooloo! Hooloo! with the accent on the Hoo syllable, is supposed to describe the sound, but it is really quite indescribable in writing.

As in other species of apes, there is a special modification of the larynx, which acts as a sort of resonating-box, and helps (I suppose) to make the sound carry, as it does, long distances. There is also a peculiar arrangement of the upper aperture of the larynx, with its small and inadequate looking epiglottis, which more resembles the arrangement in birds than the leaf-like epiglottis in man.

As, day after day, I have ridden through the jungle, it has seemed to me that the Hoolocks work their ground systematically in their search for food, just as the planter plucks one section of his tea to-day and another section on a distant part of the garden to-morrow. For I have found them filling the air with their cries along a particular stretch of jungle-road one day, whilst the next day not one was to be heard; then, perhaps, a week later they are back again in the same place. Living as they do in communities, they are constantly on the move, and from what we know of their great intelligence, it seems to me highly probable that their movements are guided by very definite plans, and that very probably they have some sort of government system.

There is a point about the Hoolock that strikes me as very extraordinary, and that is the fact that he cannot swim. I had been told this by both natives and Europeans, but I confess I was somewhat sceptical about it until I tried experiments myself. We put a full-grown Hoolock into a big tank in 10 feet of water. He struggled helplessly, as a boy would before he learns to swim. He sank twice, with head thrown back and arms waving frantically, and we were obliged to rescue him almost asphyxiated and choking in the most human way.

This weakness he shares with man, but I do not know whether (or not) it has been noted in the other anthropoids.

It is a significant fact that the range of the Hoolock is bounded by two vast rivers, the Brahmaputra on the north and the Irawaddi on the south. It may well be that, with his natural aversion to water, these rivers have confined him to the comparatively limited stretch of country he occupies. Travelling high up in the jungle, he could swing easily across the ordinary streams which would come in his path without having to take to the water. The monkeys of India take readily to water, and it is a pretty sight to see them spring out from a lofty overhanging bough and drop, one after another, with a splash into the stream, and strike out boldly for the further bank.

In Cachar, where these notes were written, the tea-planters often keep Hoolocks for years, allowing them to run loose about the compound, and they are certainly the cleanest and most interesting pets imaginable, offering a very marked contrast in this respect to the red monkeys, which, chained to a pole, are so common a feature in Indian compounds.

A Hoolock, to be tamed in this way, must be caught quite young, and not tied or shut up in any way. A native boy is generally told off to watch him for a few days, and to prevent him from bolting, but he soon learns to come down from the trees for a plantain, and he will in most cases settle down to a solitary life, remaining about the same compound for years. But chain him or restrain his liberty in any way, and he inevitably begins to mope and pine, and invariably dies in a few weeks. It is strange that the calls of the wild Hoolocks, which he must hear almost daily all round him, do not tempt him to revert to his natural life as a member of a wandering community. I imagine a Hoolock, who attempted to join a strange band, would meet with a rough reception, anyway they never try to return to the jungle after they become tame.

Several such tame Hoolocks I have had the opportunity of observing for some months past. Often they will be away up in the tree-tops for days together, when nothing will tempt them down, but when one chooses to be sociable he will come and sit on the arm of your chair at breakfast, and never reach or snatch things off the table: in fact his manners are unexceptionable, and he keeps his skin beautifully clean without that exaggerated parade of flea-hunting which makes the monkey tribe so objectionable as pets. At sunset you may see him settle down to sleep, jammed tight in a fork in a squatting position. In this semi-domesticated state I notice that the Hoolock seldom uses his voice. I suppose, leading a solitary bachelor life, he finds no necessity for chattering or calling. With regard to the diet of the Hoolock, Dr. Blanford, the Indian naturalist, gives a long list, including fruit, leaves, young shoots, spiders, insects, birds' eggs and young birds. But, it seems to me, the diet of such shy creatures must be largely a matter of conjecture, for no certain

conclusions can be drawn from the habits of captured specimens, nor can we recognize as a rule substances in the stomach of shot specimens, as we can in the crop in the case of birds. My own observations lead me to believe that fruits and the succulent shoots of young bamboos and other trees form the bulk of their diet. They will certainly catch and eat certain spiders; but I have invariably found them to refuse such insects as moths or butterflies, perhaps because many such insects have a bitter taste. Eggs, too, I found they would not eat. If you give an insect or a small bird to a Hoolock he will certainly pull it to pieces, and possibly taste or bite it, but it by no means follows that it is one of the regular dishes he enjoys in his wild life.

The following list of leaves and shoots which are eaten by the Hoolock is given by Anderson:—*Morugo pterygosperma*, *Spondias manifera*, *Ficus religiosa*, *Beta vulgaris*, *Ipomœa reptans*, *Canna indica*.

I hope later on to supplement these short notes with some anatomical observations on weight of brain relative to body, and on the number and depth of the convolutions. But this is a matter of time, for specimens are not very readily obtained. The Hindoo coolies, who form the bulk of the population in the tea-districts of Cachar, will never kill a Hoolock. The Kuki tribes in the Cachar Hills, on the other hand, kill and eat them, and regard them as somewhat of a delicacy, I believe. But even a Kuki finds it difficult to get a shot at these creatures, so shy are they and so active in their movements.

March 3, 1903.

G. A. Boulenger, Esq., F.R.S., Vice-President, in the Chair.

The Secretary read the following report on the additions made to the Society's Menagerie in February 1903:—

The registered additions to the Society's Menagerie during the month of February were 57 in number. Of these 8 were acquired by presentation, 48 were received on deposit and 1 on approval. The total number of departures during the same period, by death and removals, was 105.

Amongst the additions special attention may be directed to:—

1. An example of Cuvier's Gazelle (*Gazella cuvieri*), deposited by the Hon. Walter Rothschild, M.P., F.Z.S., on Feb. 9th. No example of this rare North-African Gazelle has been exhibited in the Gardens since 1867.

2. A Tamandua Anteater (*Tamandua tetradactyla*) from South America, received on approval on Feb. 12th. This is a very healthy and lively specimen of an animal which we have not had living in the Gardens for some years.

3. A young male Chimpanzee (*Anthropopithecus troglodytes*) about a year old, deposited by Mr. J. C. Lamprey, of the West African Regiment, on Feb. 18th. This animal is said to have been obtained at Kronko in the French Soudan, and was brought home from Sierra Leone by the depositor. It is in very good health.

4. A Frilled Lizard (*Chlamydosaurus kingi*) from Australia is the second example of this species received at the Gardens, the first having been presented by Mr. Saville Kent some seven years ago. The present specimen was presented by Mr. H. W. Fawdon on February 18th.

The Secretary read the following extracts from a letter addressed to Mr. P. L. Sclater by Major C. Delmé Radcliffe from Uganda, and exhibited the skins of a Monkey (*Cercocebus aterrimus*) and an Otter (*Lutra capensis*) obtained by his collector Mr. Doggett, and sent home by parcel post, at the same time:—

"I am sending you the skins of two monkeys—one completely prepared with bones, and the skin of the other, also skulls of both. The animals were both female. Doggett got them for me a few days ago, as I had sent him collecting by road here from Entebbe. This monkey is quite new to me. I shall be glad to hear from you if it is a new species. It is very interesting, and the skull has some interesting features, for instance the small canines. The hair is curiously like a Chimpanzee's. Doggett tells me he thought from the noise they made that they were Chimpanzees at first. Is it a true *Cercopithecus*? It interests me very much, and I shall be

glad of your opinion. In the same parcel I enclose a Lake Otter skin."

Mr. F. E. Beddard, F.R.S., exhibited the mounted skin of the Greater Bird of Paradise (*Paradisea apoda*) that had lately died in the Society' Gardens.

Mr. J. L. Bonhote, F.Z.S., exhibited a photograph of two tame Elephants in Ceylon accompanied by a baby one, which latter showed a considerable amount of hair, especially on the forehead. One of the old Elephants in the photograph, presumably the mother, also showed a certain amount of hair.

With reference to a recent paper by Col. C. E. Stewart, dealing with the real home of the Tiger, Mr. J. L. Bonhote said that he had asked a friend of his, a Sanskrit scholar at Cambridge, as to whether there was a word for the tiger in Sanskrit; the reply was in the affirmative, the word being *vyāghra* (or in the Pali form, *vyaggho*). This note was not brought forward against the fact of the original home of the tiger being in the north, but to support Mr. Thomas's contention that it had not spread south so recently as Col. Stewart was inclined to believe.

Professor F. Jeffrey Bell, F.Z.S., exhibited a specimen of a Holothurian of the genus *Actinopyga* from shallow water off Zanzibar, in which there was not only an oral extremity with tentacles, as in the *Cucumaria planci* described some ten years since by Prof. Ludwig, but also an anal extremity; these additions (whether the result of gemmation or of fission cannot at present be said) do not occur in the same radius of the Holothurian.

The following papers were read:—

1. On a new Species of Pigmy Antelope of the Genus *Neotragus* from the Cameroons District, W. Africa. By W. E. de Winton, F.Z.S.

[Received March 3, 1903.]

(Plate XIX. & Text-fig. 29.)

In a collection lately received from Mr. G. L. Bates from the Cameroons are two specimens, male and female, of a new form of Pigmy Antelope, adding a second species to the genus *Neotragus*. I propose to name this very interesting new form in honour of the collector, who has added so much to our knowledge of the fauna of the Cameroons country.

H. Goodchild, del. et lith.

Neotragus batesi

Neotragus batesi, sp. n. (Plate XIX.)

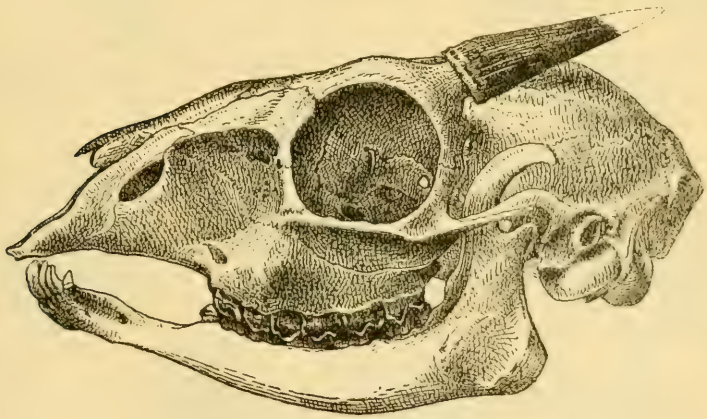
Size nearly half as large again as the Royal Antelope, *N. pygmæus*. The colour darker and slightly more smoky, the feet not so rufous, and the whitish markings of the underparts not so pure.

The front of the face, crown of the head, and neck are dark smoky-brown, the back and upperside of tail more rufous or bay-coloured. All the fur annulated with dark brown and bright bay.

The type of this new species, a male, bears the following notes on the label attached by the collector:—"Efulen, Bulu Country, Kamarun, 1500 ft. above sea. Caught in trap on edge of garden, 15 Sept. 1902." Measurements: head and body 540 mm., tail 65, hind foot (without hoof) 160, ear (inside from notch) 50.

Dimensions of skull of male (text-fig. 29):—Greatest length 107 mm.; basal length 95; greatest breadth 51 (below orbits); breadth of brain-case 37·5; orbit to points of premaxillæ 48; length of nasals (middle line) 33; length of frontals 33; length of parietals 30; length of interparietals 13; greatest breadth of

Text-fig. 29.



Skull of *Neotragus batesi*.

nasals 20; breadth in narrowest part 9; length of horn (broken) 27, the perfect horn could not be less than 35 mm. in length; distance between bases of horns 25; distance between tips (*circa*) 35; length of orbit 23; height of orbit 22; length of upper tooth-row 32; breadth of palate between pms.[1] 17, between ms.[1] 20, between ms.[3] 21·5.

The dimensions of the skull of the female are practically the same as those of the male.

The discovery of this new species extends the range of the genus *Neotragus* very considerably, for the Royal Antelope (*N. pygmæus*) is found only on the Gold Coast from Liberia to Lagos.

An examination of the skull somewhat modifies the definition of the genus as laid down in 'The Book of Antelopes' by Sclater and Thomas; for in this new species are found extra maxillo-premaxillary vacuities 9 mm. long and 3 mm. broad, very similar to those found in the genus *Nesotragus* of East Africa. The horns again of the members of this genus cannot be said to be "less than the diameter of the eye" in length; for the horns of the type of this new species, in their broken state, are longer than the diameter of the orbital cavity, and would undoubtedly measure half as much again in their perfect state. These horns are not "perfectly smooth," but show slight ridges or rings in their basal portion. The skull is otherwise fairly similar to that of the Royal Antelope.

There can be no doubt that Bates' Pigmy Antelope somewhat bridges over the differences between this genus and the East-African *Nesotragus*, and practically reduces the distinguishing characters to those of the horns alone.

The horns of *Neotragus* are very small, practically smooth, and laid back on the head in a plane with the forehead; while those of *Nesotragus* may be half as long as the head or more, strongly and closely ridged and directed upwards.

2. On the Land Operculate Mollusca collected during the "Skeat Expedition" to the Malay Peninsula in 1899–1900. By E. R. Sykes, F.Z.S.

[Received February 2, 1903.]

(Plate XX,[1])

The species of Land-Mollusks collected by the "Skeat Expedition," though not very numerous, are of considerable interest on account of the welcome addition made to a fauna which is as yet but little known. They include:—

Leptopoma aspirans Benson.

Leptopoma aspirans Benson, Ann. Nat. Hist. ser. 2, vol. xvii. p. 229.

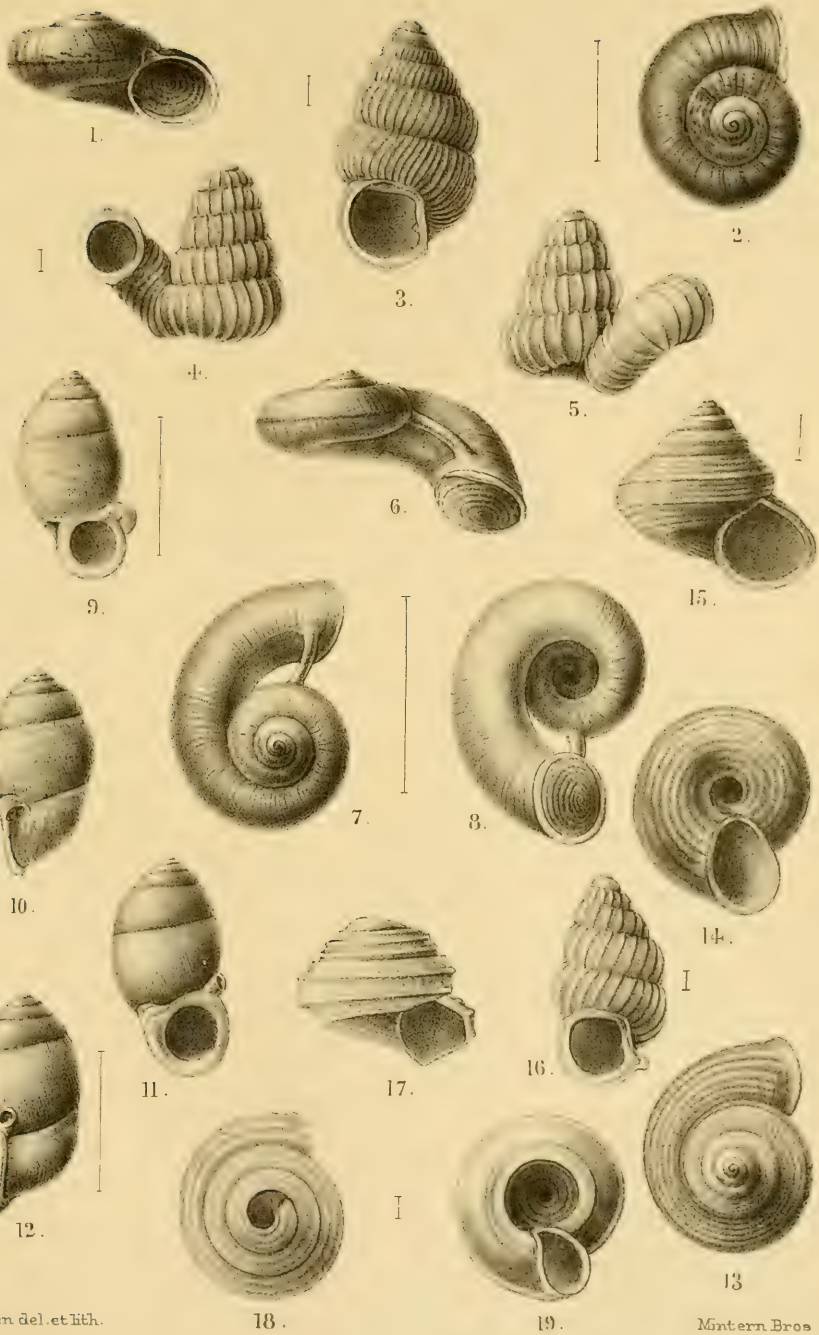
Hab. Biserat, Jalor. It has been recorded from Bukit Pondong and the Kinta Valley, having been originally described from Tenasserim.

Lagochilus kobelti, sp. nov. (Plate XX. figs. 13–15.)

Testa modice umbilicata, turbinata, solidula, lirulis numerosis cincta, periostraco brunneo leviter induta; spira conica; anfr. 5½, *convexi; apertura modice obliqua, subcircularis, peristomate duplici, incrassatulo et subreflexo, juxta insertionem breviter sed distincte inciso. Alt.* 6·8; *diam. max.* 7·0 *millim.*

Hab. Biserat, Jalor.

[1] For explanation of the Plate, see p. 199.



J. Green del. et lith.

Mintern Bros imp.

MOLLUSCA FROM THE MALAY PENINSULA.

The species of *Lagochilus* recorded from the Malay region are very puzzling and I think Dr. Moellendorff was quite right in describing as *L. rollei* the form that I noted (under the name of *L. townsendi*) from Kelantan. The nearest ally of *L. kobelti* appears to be *L. townsendi* Crosse; I have not seen an authentic specimen of that species, but have compared the form now described with the description and figures given by Crosse and with a specimen collected by Herr Grubauer, from whose collections Dr. Moellendorff has recorded *L. townsendi* as the only species found. The shell I now name is a trifle smaller and more elevated in proportion to the breadth, and the umbilicus is narrower. It may be noted that the reference to Crosse's original paper in the 'Journal de Conchyliologie' should be to p. 200 and not p. 208 as given by De Morgan and Dr. Moellendorff in their papers on the Perak fauna.

I have named the form after Dr. Kobelt as a trifling recognition of his recent study of the Cyclophoridæ.

Ditropis cavernæ, sp. nov. (Plate XX. figs. 17–19.)

Testa depresso-conoidea, late umbilicata, olivacea, tenuis, glabra; spira mediocriter elevata, apice croso, sutura impressa; anfr. 4 (?), *convexi, ultimus antice vix descendens, carinatus, carinis duabus supra peripheriam, unica ad peripheriam, et plurimis in regione umbilicali; apertura subovalis, peristomate incrassatulo. Alt.* 2·2; *diam. max.* 1·7 *millim.*

Hab. In a cave, Biserat, Jalor.

A single specimen only.

Cyclophorus malayanus (Benson).

Cyclostoma malayanum Benson, Ann. Nat. Hist. ser. 2, vol. x. p. 269.

Hab. Gunong Inas, Perak.

Recently when cataloguing (J. Malac. ix. p. 61) a collection of shells from Kelantan, I gave the names of *Cyclophorus saturnus* Pfr. and *borneensis* Metc.: both the forms then recorded have occurred in the present collection, and I have therefore again considered the identifications. Both, according to my present view, are erroneous, and the group is a very difficult one. The present species, which I regard as a form of *C. malayanus*, was then named *C. saturnus*, and the next species was called *C. borneensis*.

Cyclophorus tuba (Sby.).

Cyclostoma tuba Sowerby, Proc. Zool. Soc. 1842, p. 83.

Hab. Gunong Inas, Perak.

See remarks under the last species; probably the *C. borneensis*, recorded by De Morgan from Perak, also belongs to this species.

Pterocyclos subalatus, sp. nov. (Plate XX. figs. 1, 2.)

Testa late umbilicata, orbiculato-depressa, lineis incrementi notata,

brunnea, strigis corneis picta, fascia unica nigro-brunnea ad peripheriam ornata; anfr. 4½, *mediocriter crescentes, convexi, sutura bene notata separati; apertura subcircularis, peristomate indistincte duplicato, ala parva antice angulato. Alt.* 8; *diam. max.* 16 *millim.*

Hab. Gunong Inas, at 5000 feet.

I thought at first that this might be a form of *P. blandi* Bens., but it appears to be smaller, more elevate and not so widely umbilicated, and to differ in colour. In the two specimens that I have seen the lip is duplicated only on its outer margin, and the wing is small and thin.

Rhiostoma jalorensis, sp. nov. (Plate XX. figs. 6–8.)

Nearly related to *R. housei* but larger, slightly more depressed, and with the whorls not so tightly coiled. The tube is long and large, reaching the body of the shell, and is bent slightly backwards at the junction. The disjoined portion of the last whorl is much longer than is the case in *R. housei*, as will be seen from the figure, and is more descending. The colour resembles that of *R. housei*, and a dark band is usually present at the periphery. Operculum as usual. Diam. max. 29 millim.

Hab. Limestone Hills and Caves, Biserat, Jalor.

I have been in some doubt as to whether this is not a local race of *R. housei*, but the differences are constant in the specimens examined and, I think, are of specific value. The porcellaneous appearance of the operculum, so often seen in this group, appears to be due to the wearing down of the outer layers.

Rhiostoma, sp.

Hab. Kwala Aring, Kelantan.

A single specimen which agrees well with *R. jousseaumei* De Morgan, save that the tube is placed a little further back from the mouth, and is thinner and more cylindrical. It appears safer, however, to await further material ere describing this form.

Opisthoporus penangensis Stol.

Opisthoporus penangensis Stoliczka, J. As. Soc. Bengal, vol. xlii. pt. 2, p. 265, pl. x. fig. 7.

Hab. Kwala Aring, Kelantan.

A single specimen, which I refer to this species with some doubt.

Rhaphaulus ascendens, sp. nov. (Plate XX. figs. 11, 12.)

Testa pupoidea, anguste umbilicata, fusco-purpurea, dense costulato-striata, spira bene elevata, apice obtusulo; anfr. 6, *plano-convexi, penultimus gibbosus; apertura subcircularis, intus pallide fusca; peristoma pallide corneum, expansum et reflexum, marginibus callo junctis; tubulus brevis, incrassatus, a sutura oblique ascendens. Alt.* 18·5; *diam. max.* 9·5 *millim.*

Hab. Patalung.

A single specimen "from rotten wood." Recalling in shape *R. perakensis* Smith, the present species is larger and stouter, and the tube slants obliquely upwards instead of descending; as compared with *R. lorraini* Pfr., which also has an ascending tube, the form is not so cylindrical, the whorls are flatter, and the size is much greater.

Rhaphaulus perakensis Smith, var. jalorensis, n. var. (Plate XX. figs. 9, 10.)

Shell very similar to *R. perakensis* Smith, but a little thinner and paler in colour, and the tube is bent along the outer lip, being attached to the lip, and not diverted behind it as in typical *R. perakensis*. The tube is broad and short. This form may prove to be a distinct species, but bearing in mind the great variation shown by Col. Godwin-Austen (Moll. India, vol. i. p. 202, pl. xlvii.) to exist in *R. blanfordi* Benson, and also considering how little we know of the group, most forms having been described from very few specimens, I have thought it wiser to give only a varietal name.

Hab. Bukit Bisar, on the borders of Jalor, altitude 2000 feet.

A single specimen.

Schistoloma anostoma (Benson).

Cyclostoma anostoma Benson, Ann. Nat. Hist. ser. 6, vol. x. p. 269.

Hab. Belimbing, Ligeh.

Schistoloma sectilabrum (Gould).

Cyclostoma sectilabrum Gould, Boston Journ. Nat. Hist. vol. iv. p. 459, pl. xxiv. fig. 10.

Hab. Ulu Selama, Perak.

Pupina lowi De Morgan.

Pupina lowi De Morgan, Bull. Soc. Zool. France, vol. x. 1885, p. 414, pl. vii. fig. 3 (*louri* on plate).

Hab. Gunong Inas, Perak.

Pupina aureola Stoliczka.

Pupina aureola Stoliczka, J. As. Soc. Bengal, vol. xli. pt. 2, p. 267, pl. x. figs. 11, 12.

Hab. Jalor, a single specimen.

Agrees well with Stoliczka's figure 12, but his figure 11 looks as if it might belong to a different species.

Alycæus thieroti De Morgan.

Alycæus thieroti De Morgan, Bull. Soc. Zool. France, vol. x. 1885, p. 403, pl. viii. fig. 6; Moellendorff, Proc. Zool. Soc. 1891, p. 342.

Hab. Belimbing, Ligeh, a single specimen.

ALYCÆUS DIPLOCHILUS Moellendorff.

Alycæus diplochilus Moellendorff, J. As. Soc. Bengal, vol. lv. pt. 2, 1886, p. 313; Proc. Zool. Soc. 1891, p. 342, pl. xxx. fig. 8.

Hab. Cave near Biserat, Jalor.

ALYCÆUS CONFORMIS Fulton.

Alycæus conformis Fulton, Ann. Nat. Hist. ser. 7, vol. ix. 1902, p. 68.

Hab. Kwala Aring, Kelantan.

ALYCÆUS PERAKENSIS Crosse.

Alycæus perakensis Crosse, J. Conchyl. vol. xxvii. 1879, p. 206, pl. xii. fig. 7.

Hab. Biserat, Jalor, amongst rocks.

OPISTHOSTOMA ANNANDALEI, sp. nov. (Plate XX. figs. 4, 5.)

Testa conico-pyramidalis, perforata, pallide rufescens, spira bene elevata, apice obtuso; anfr. 7, *convexi, primi læves, reliqui distante lamellati, ultimus constrictus, retroversus, ascendens, conspicue solutus; apertura rotundata, peristomate leviter incrassato. Alt.* 2·2; *diam. max.* 2·8; *diam. min.* 1·6 *millim.*

Hab. Jalor.

A single specimen, found by Mr. Annandale in débris on the floor of a cave. Related to *O. laidlawi* Sykes, from Kelantan, but the present species is larger, and the spire is much more produced, thus becoming more cylindrical in appearance.

DIPLOMMATINA SKEATI, sp. nov. (Plate XX. fig. 3.)

Testa sinistrorsa, vix rimata, ovato-fusiformis, aurantio-rufa, solidiuscula; anfr. $6\frac{1}{2}$, *convexi, primi læves, reliqui costulis parvis subremotis regulariter sculpti; sutura bene impressa; apertura fere circularis, peristomate incrassatulo, bene reflexo, subalato; lamella columellaris parva. Alt.* 3·1; *diam. max.* 1·9 *millim.*

Hab. Gunong Inas, Perak, at about 5000 feet.

Only a single specimen of the shell, the most salient features of which are the inflated whorls, deeply cut suture, and fine, regular costulations.

DIPLOMMATINA LAIDLAWI, sp. nov. (Plate XX. fig. 16.)

Testa sinistrorsa, rimata, ovato-fusiformis, corneo-albida, apice rubello; anfr. $5\frac{1}{2}$, *convexi, primi læves, reliqui costulis parvis remotis regulariter sculpti, interstitiis sub lente dense spiraliter striatis; apertura quadrato-circularis, peristomate duplici, expanso, margine columellari sinuato, subalato; lamella columellaris minima, indistincta. Alt.* 2; *diam. max.* 1 *millim.*

Hab. Gunong Inas, 3000–4500 feet, Perak.

Found "on the under surface of dead leaves, young with adults."

Much smaller than the last species, the costulæ more distant, and densely marked with minute spirals. I can find no trace of these latter in *D. skeati*, but the single specimen was not taken alive.

GEORISSA MONTEROSATIANA Godwin-Austen & Nevill.

Georissa monterosatiana Godwin-Austen & Nevill, P. Zool. Soc. 1879, p. 729, pl. lix. fig. 6.

Hab. Perak.

EXPLANATION OF PLATE XX.

Figs. 1, 2. *Pterocyclos subalatus*, p. 195.
3. *Diplommatina skeati*, p. 198.
4, 5. *Opisthostoma annandalei*, p. 198.
6, 7, 8. *Rhiostoma jalorensis*, p. 196.
9, 10. *Rhaphaulus perakensis*, var. *jalorensis*, p. 197
11, 12. *Rhaphaulus ascendens*, p. 196.
13, 14, 15. *Lagochilus kobelti*, p. 194.
16. *Diplommatina laidlawi*, p. 198.
17, 18, 19. *Ditropis cavernæ*, p. 195.

3. The Significance of the Callosities on the Limbs of the *Equidæ*. By R. LYDEKKER, F.Z.S.

[Received February 5, 1903.]

The question as to what structures in other mammals are represented by the callosities on the inner sides of all the limbs of the Horse, and those of the hind-limbs of the Kiang, Ass, and Zebras, is one which has attracted the attention of many naturalists, nearly all of whom appear to be in accord in regarding them as vestigial structures. The late Sir W. H. Flower, for instance, in his work 'The Horse' expressed the opinion that these structures are degenerate glands; pointing out at the same time that the so-called ergot on the hinder aspect of the horse's pastern appears to represent one of the pads, or cushions, which are still functional in the foot of the Tapir.

In his volume on "Mammalia" in the 'Cambridge Natural History'[1], of which the preface is dated February 1902, Mr. Beddard gives a qualified support to this gland-theory; stating in one passage that the equine front callosities probably correspond to the carpal glands of several other mammals, although on another page their glandular nature is questioned. In an apparently later communication[2] the same gentleman suggests that the callosities on the fore-limbs of the *Equidæ* may represent a carpal sense-organ, vestiges of which he believes to survive in the carpal bristles of the Dassies. The degeneration of such an organ would, it is urged, very likely result in the formation of structures resembling those under consideration.

[1] Pp. 12, 13, and 240.

[2] Proc. Zool. Soc. 1902, i. p. 135.—I am indebted to Mr. Beddard himself for directing my attention to this passage.

There has, however, long existed an idea that the equine callosities are remnants of a vanished toe. Somewhat analogous to this idea is a theory, which has been advanced in a paper lately read before the Royal Society of Edinburgh by Prof. Ewart[1]. That gentleman, it appears, has based his investigations to a very great extent on the condition obtaining in the fœtus; and has arrived at the conclusion that the callosities in question have nothing to do with glands, but that they represent certain foot-pads of polydactyle mammals. According to Prof. Ewart's view, the fore-callosity of the Horse is homologous with the supplemental pad on the fore-foot of the Dog, while the hind callosity (which is wanting in all existing *Equidæ* save the true Horse and the so-called *Equus przewalskii*) corresponds to the hinder plantar pad of the Banded Anteater (*Myrmecobius fasciatus*). Such correlations will, I venture to think, scarcely be taken seriously by the great majority of zoologists; and I shall therefore confine my attention to the question whether the identification of these callosities with foot-pads generally is well founded. In all cases my observations are confined to the condition obtaining in adult animals. It may be added that I purposely brought these observations to the notice of the Society before the publication of Prof. Ewart's paper, since I treat the subject from a different standpoint.

In the first place, the callosities on both limbs of the Horse are situated on the inner surface, whereas, if they represented vestigial foot-pads, their position should be, *primâ facie*, on the hinder aspect, as is the case with the ergot. It might, indeed, be argued that they have changed their original position, but of such a shifting there is no evidence in the adult. A second, and perhaps more important, objection to the foot-pad theory may be drawn from the fact that the callosities in the fore-limb are situated above the so-called knee-joint (carpus), and are therefore altogether higher up than any of the foot-pads of plantigrade mammals. Unless, therefore, another shift of position has taken place, the fore-callosities do not represent foot-pads. This argument, it may be mentioned, was used by Sir W. H. Flower to disprove the theory that the callosities are remnants of the lateral digits.

The hind-callosities, on the contrary, are situated a short distance below the joint of the hock (tarsus), and are therefore on a part of the limb, albeit on its inner side, which is included in the foot of a plantigrade mammal. If, however, the front callosity be regarded as serially homologous in a general sense with the hind one—and this is an integral part of Prof. Ewart's theory,—it will be evident that in the event of the former not being a foot-pad, the same will hold good for the latter.

A third, and perhaps stronger, objection may be urged against the foot-pad theory. On the assumption that the callosities of the existing *Equidæ* are vestiges of foot-pads, it is clear that these

[1] See 'Nature,' vol. lxvii. p. 239 (1903).

structures must have existed in the ancestors of that family ever since the time when these ancestors were plantigrade. But, so far as I know, no ungulate was ever wholly plantigrade in both feet; the nearest approach to this condition obtaining in the Lower Eocene *Coryphodon*, in which the hind-limb was wholly plantigrade, while the front one was partially digitigrade. It has thus to be assumed, on the foot-pad hypothesis, that the front callosities of the Horse have been functionless structures from a period antedating the evolution of the Ungulata. Such a persistence, on exposed parts of the body, of a wholly functionless structure seems very improbable, especially when the modifications are borne in mind which, on this hypothesis, the horse-line must have undergone since the time when the callosities were functional structures. Perhaps the case of the ergot may be cited against this argument; but it should be remembered that this structure certainly acted as a functional pad at a much later stage of evolution than could possibly have been the case with the callosities.

Having now stated what appear strong objections, so far as the adult is concerned, against correlating the callosities of the Horse with the foot-pads of polydactyle mammals, it remains to consider whether they can be identified with any other structures. Those familiar with the morphology of the *Cervidæ* will be aware that a certain number of representatives of that family—notably the reindeer, the White-tailed Deer, the Mule-Deer, and, in a rudimentary condition, the Elk,—are furnished on the inner side of the hock with a glandular tuft corresponding very closely in situation with the hind-callosity of the Horse. In fact, the only difference in the position of the two structures is that the tarsal tuft of the Deer in question is placed rather lower on the hock. From the fact of its occurrence in Deer so widely separated from one another as are the species mentioned, it seems evident that the tarsal gland (which is doubtless a scent-organ) is a very ancient structure, which was present in all the ancestors of the group, but has been lost, probably from disease, in the great majority of Old World forms.

Judging from their position, there would seem to be a certain probability that the hind-callosities of the Horse and the tarsal gland of the Deer are homologous structures.

With regard to the homology of the fore-callosity of the *Equidæ*, it may be mentioned that many Gazelles have tufts of hair ("knee-brushes") at the knee (carpus), which are probably glandular in origin. And it is possible (if the suggestion with regard to the hind-callosities hold good) that these may represent the fore-callosities of the Horse, for there seems no good reason why the position of a gland should not have somewhat shifted in two widely separated groups of mammals. Then, again, we have the carpal bristles of certain mammals, such as the Coatis and Dassies, already referred to as being regarded by Mr. Beddard as the remnants of a "scent-organ,"—a structure probably not far removed in its nature from a gland. The occurrence of these

bristles in the Dassies (*Procavia*) is very important. Mr. Beddard states that these are the only ungulates in which he has found these bristles. Carpal callosities are, however, described by Dr. W. Leche[1] as occurring in Wart-Hogs (*Phacochœrus*); although they are stated by their describer to be acquired, and not primitive structures. Whether the latter statement is calculated to modify Mr. Beddard's opinion with regard to the nature of the carpal bristles in the Dassies, I am, of course, unable to say. Of special importance is the occurrence of bristles in these structures, since, even if hairs be found to exist on the callosities of fœtal *Equidæ*, this would be no bar to the supposition of their glandular nature.

As regards the structure of the callosities themselves, it may be noted that in the Horse both pads are of a distinctly warty nature, and that the hind pair are certainly in a more decadent condition than the other, being in fact on the verge of disappearing. In the Zebras, on the other hand (in which the hind one has been lost), the fore-callosity is larger and much less warty and also situated higher up. In dried skins it is, in fact, much more like the pale glandular patch of skin below the ear of a Reedbuck[2]. In this connection we have to bear in mind not only Mr. Beddard's observations alluded to above, but likewise others by Mr. Bland Sutton[3], in which it is pointed out that in certain Lemurs decadent glands are actually converted into bunches of spines, which are practically almost the same as warts; that is to say, they are hypertrophied growths of somewhat abnormal dermal tissue. Hence there seems no *primâ facie* reason why the callosities of the *Equidæ* should not be decadent glandular structures, the decadence being more marked in the two pairs of callosities of the Horse than in the single pair of the Asses and Zebras.

There is, however, another point which may have an important bearing on the subject. From the presence of a depression in the skulls of *Hipparion*, *Hippidium*, &c., it is evident that primitive Horses were furnished with face-glands comparable to those of Deer; such glands probably having a function somewhat analogous to that of the scent-glands on the limbs of the latter. If, then, the existing *Equidæ* have got rid of their face-glands, as being (perhaps on account of change of habit) useless, it is conceivable that, for the same reason, they may have also discarded their limb-glands.

If these suppositions (and they are but suppositions) be well founded, it follows that a tarsal and a carpal gland must have existed in the common ancestors of the Horses and Deer; that is to say, in the common stock of all modern Ungulates save the Elephants and perhaps the Dassies. And it may be urged that if this were the case, traces of such glands ought to be met with in Tapirs, Rhinoceroses, Pigs, Hippopotamus, &c. So far as I am

[1] Biol. Centralblatt, vol. xxii. p. 79 (1902).

[2] It would be important to examine the histological structure of the callosity in a Zebra.

[3] Proc. Zool. Soc. 1887, p. 369.

aware, the only instances of structures which can be regarded as at all approaching this nature are the carpal bristles of the Dassies and the carpal callosities of Wart-Hogs, the latter of which, as already mentioned, are considered to be of modern origin. No trace of any structure comparable with the hind-callosity of the Horse has, so far as I am aware, ever been detected on the tarsus of any of the above-mentioned Ungulates.

If an objection of this nature be regarded as fatal to the gland-theory (or sense-organ-theory, for I regard the two as practically identical) of the origin of the equine callosities, it will, I think, be still more so to the foot-pad hypothesis, since short-limbed and polydactyle mammals ought to have retained traces of ancestral foot-pads for a greater period than long-limbed monodactyle forms like the *Equidæ*.

In conclusion, I may state that it has been my object, not so much to attempt to show what the equine callosities represent, as to demonstrate, from palæontological considerations, the improbability of their being vestigial foot-pads.

P.S.—I am informed that if a callosity be pared down, and a finger moistened with the resulting exudation held to a horse's nose, the animal will follow anywhere. If this be true, it affords strong testimony in favour of the gland-theory.

4. Note on some Remains of *Struthio karatheodoris* Maj. of the Island of Samos. By Rudolf Martin, of Basel University.[1]

[Received February 11, 1903].

(Text-figures 30–34.)

In the Catalogue of the collection of Mr. Barbey at Valleyres s./Orbe (Switzerland), published in 1894 by Dr. Forsyth Major[2], besides a great number of mammals there is mentioned the femur of a ratite bird, which, no doubt, belonged to the genus *Struthio* (Dr. Major could scarcely find any difference). Dr. Major, considering the geological age of the deposits in which the bone had been found (Upper Miocene), and recognising that it belonged to a form different from the recent Ostrich, created the new species *Struthio karatheodoris*.

Some time ago, Dr. Major received the fragment of a pelvis from the Museum of the Vienna University (found in the same place as the femur), which probably belonged to the same species, and which is the subject of the following remarks.

I have to thank Dr. Major for having entrusted me with the study of this pelvis and for having placed two photographs of the

[1] Communicated by Dr. C. I. Forsyth Major, F.Z.S.

[2] Le Gisement ossifère de Mitylini et Catalogue d'ossements fossiles recueillis à Mitylini etc., Lausanne, 1894.

femur (rostral and caudal aspect) at my disposal, on which the following description is based.

Evidently this *femur* (text-figs. 30, 31) belonged to a large struthious bird, as it differs little from the same bone of a modern Ostrich. The size of the femur is somewhat larger than that of the same bone of recent Ostriches at my disposal, but very probably there would be no difference between a large specimen of *Struthio camelus* and the fossil.

Text-fig. 30.

Text-fig. 31.

Text-fig. 30.—Right femur of *Struthio karatheodoris*. Caudal view. $\frac{1}{4}$ nat. size.
Text-fig. 31.— „ „ „ „ Rostral view. $\frac{1}{4}$ nat. size.

The following table gives the results of a comparison between the fossil in question and that of a medium-sized modern ostrich :—

Species.	Length of femur.	Length of caput + collum.	Smallest width.	Width of trochlea.
Str. karatheodoris	36·0	10·5	5·5	12·4 mm.
Str. camelus	31·2	10·0	5·2	11·5 mm.

The measurements of the caput + collum have been taken

from the apex of the caput to the margin of the trochanter, and that of the trochlea in the direction of its greatest expansion.

A close study of the bone, however, revealed some features in which the fossil differs from the recent Ostrich, on the supposition that the photograph is not distorted.

In the fossil, the *neck* supporting the *head* of the femur is much stouter than in the recent species and is much less constricted. This is best seen in the form of the distal border of the collum.

Although measurements may include an error of, say, $\frac{1}{10}$, they give an idea of that feature, because the difference between the two species exceeds that error. The only measurable line is the plummet in the apex of the head to the *linea aspera*, dividing the rostral surface of the neck from that of the bone itself.

Width of the neck = 1.

Struthio camelus = 3·6666+

,, *karatheodoris* = 3·1666+

It seems to me that the groove in which the *ligamentum teres* is inserted is shallower in the fossil than in *Struthio camelus*. It may be that the photograph gives a wrong impression, and I think it would be better not to regard this feature as a specific one.

Text-fig. 32.

Pelvis of *Struthio karatheodoris*. Ventral view.

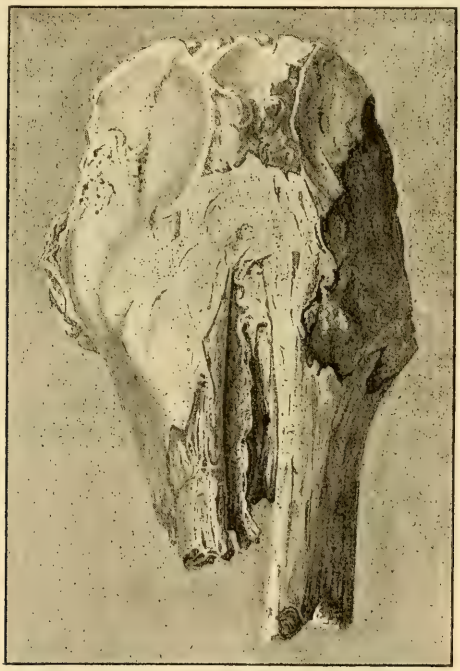
a & *b* = true sacral vertebræ. i., ii., & iii. = first three postsacral vertebræ.
$\frac{1}{3}$ nat. size.

The *trochanter* and the *lineæ asperæ* of the proximal end of the femur are not to be distinguished from the same parts in the recent Ostrich; even the pneumatic foramen in the caudal surface is found in the same place.

The middle part of the bone is just as in *S. camelus*, nd the distal end differs only in one particular: the *fossa intercondyloidea* is much elongated, so as to form a slight valley in the distal $\frac{1}{3}$ or $\frac{2}{5}$ of the rostral surface of the femur. In the caudal surface, immediately above the proximal border of the trochlea, there is also a funnel-shaped pneumatic foramen which enters the bone obliquely (from the mesial border of the bone, and is directed towards the middle of the axis of the trochlea). As in the recent Ostrich, there is a tuberosity between the wide orifice of that foramen and the mesial edge of the caudal surface.

The *pelvis* (text-figs. 32–34) differs in some respects rather considerably from that of the recent Ostrich; but the individual

Text-fig. 33.



Pelvis of *Struthio karatheodoris*. Dorsal view.

variation met with in the recent form, and very probably also in the fossil, shows that the difference is much less than it seemed to be at first sight, and very probably the extreme variations of the two forms closely approach.

The pelvis at my disposal is represented only by a fragment from the last *presacral* to the third *postsacral* vertebra (6 vertebræ, the first and the last incomplete), and in connection with it the corresponding parts of the *ilia*, *i.e.* the acetabular and immediately postacetabular region. The *acetabula* themselves are not entirely preserved, but only the caudal border of that on the left is quite intact, and the *antitrochanter* is broken away on both sides, so that on the left side only its outlines can be determined.

Text-fig. 34.

Lateral view of the pelvis of *Struthio karatheodoris*. $\frac{1}{4}$ nat. size.

In the principal and most characteristic features, the fossil does not differ from *S. camelus*, and there can be no doubt that the ratite bird of Samos belonged to the same genus.

In the following features the fossil pelvis agrees with or differs from that of the recent *Struthio*:—

i. The pelvis is compressed from both sides in the same manner as in *Struthio camelus* (though the compression is a little less marked), so that the dorsal aspect of it is much as in the recent form.

ii. The *sacral vertebræ* of the fossil are much stouter. The same irregular sculptures occur, forming rough longitudinal ridges.

iii. The centra of the two "*true sacral vertebræ*" are, compared with the following centra, narrower, but better rounded than in the recent Ostrich.

iv. The *acetabulum* has quite the same position as in *S. camelus*.

v. The plane between the ventral border of the antitrochanter and the dorsal edge of the foramen obturatorium is—in comparison with *S. camelus*—turned forward, *i.e.* it slopes more rapidly towards the acetabulum.

vi. The outlines of the *antitrochanter* are just as in *S. camelus*, and its size is also the same.

vii. The *ilia* of the fossil and the recent Ostrich are closely similar. There is no difference in the dorsal view of the pelvis exceeding possible individual variation. The vertical

distance between the antitrochanter and the lateral edge of the *area dorsalis* is relatively longer in the fossil than in most of the recent medium-sized Ostriches; but on one side this distance cannot exactly be determined in the fossil (because the antitrochanter is broken away and the edge of the area dorsalis is much rounded), and on the other side the individual variation in this regard in *S. camelus* is very great. The largest individuals of this species differ but little from the fossil, and very probably the fossil pelvis at my disposal must be referred to an adult and rather large animal.

The distance between the dorso-mesial borders of the ilia is somewhat shorter in the fossil than in most of the pelves of *S. camelus* with which I have compared it. But it is in this respect that individual variation has the greatest amplitude, and in the largest pelvis of *S. camelus* at my disposal this distance is equal to that of the fossil.

	S. karatheodoris.	*S. camelus.*
Costal process of the 1st "true sacral vertebra" to the distal border of the 2nd postsacral vertebra	7·8 cm.	9·2 cm.
Width of the centra of the "true sacral vertebræ"	2·5	1·8
Width of the centrum of the 2nd postsacral vertebra	2·8	2·3
Greatest width of the dorsal surface of the pelvis	12	12·2
Plummet in the dorsal border of the antitrochanter to the median plane	ca.12	12
Plummet in the dorsal border of the antitrochanter to the plane of the dorsal surface of the pelvis	ca.6·5	4

The results show that there are great differences in the proportions of the pelvis of the two species which justify a separation of the fossil from the recent Ostrich. The individual variation, however, does not allow us to place the two forms in different genera, because it greatly reduces the differences above mentioned.

I have said that the separation of the two Ostriches in different species was justified. On the other hand, the question arises, whether or no the differences between the two forms be not the consequences of a pressure acting during the great tectonic transformations in the region between Asia Minor and Greece. A study of the other fossils of Samos, however, gives no evidence of such a force; there is only a lateral compression to be seen, a result of the pressure of the weight of the more recent strata.

These considerations add to the importance of the features which I have selected for special comment, whilst on the other hand other

features lose their systematic value. But I have shown that the latter had really already lost their importance because of their individual variation.

The species *Struthio karatheodoris* Maj. is therefore to be kept separate.

What are the relations between *S. karatheodoris* and *S. asiaticus* from the Siwalik Hills? I can now give further information on *S. asiaticus*. A comparison of the fossils with the figures on the unpublished plate R of Falconer's 'Fauna Antiqua Sivalensis,' and those accompanying Davies'[1] paper and Lydekker's[2] description, did not reveal any differences, except that the drawings in Falconer's Atlas are much better than the others. Davies found that the principal difference between *S. asiaticus* and *S. camelus* lies in the greater stoutness of the cervical vertebræ in the former; and Lydekker kept the two species separate only on account of this feature. The answer to the question, whether the greater stoutness of the sacral vertebræ on one side and that of the cervical vertebræ on the other indicates a special relationship, cannot be given now. There is no evidence for such relations; and I, for my part, consider this character in the fossil forms (compared with the modern Ostriches) only as more primitive.

There may be reason to unite the two forms in one species; but considering their different geological ages[3], I think it will be better not to do so. But there can be no doubt that *Struthio asiaticus* is in direct relation with *S. karatheodoris*, *i. e.* that the former is a descendant of the latter, as Dr. Major[4] supposes the whole Siwalik fauna to be a later and transformed generation of the upper Miocene fauna of Pikermi and Samos.

It is noteworthy therefore that *S. karatheodoris* and *S. asiaticus* give us no evidence for a specialisation of the Struthionidæ in Southern Eurasia[5], and a consequent emigration into Southern Europe, Syria, and Africa, but support rather the view that the order of migration took place in the opposite direction. However, the genesis of the Struthionidæ cannot, as Burckhardt[6] is inclined to suppose, be associated with the Müllerornithidæ; for the geological age of the former is opposed to such an hypothesis.

By the discovery of a *Struthio* in the island of Samos, the egg on which the species of *Struthio chersonensis* Brandt[7] has been based is of some interest. Though the circumstances surrounding its discovery may be somewhat obscure, yet the size and proportions show that it cannot be the egg of a modern Ostrich; that it really

[1] Davies, Geol. Mag. 1880. [2] Lydekker, in Palæontologia Indica, 1884–86.
[3] Lydekker, Fossil Vertebrata of India: Records Geol. Survey, India, vol. xx. 1887.
[4] *Op. cit.* Comptes rendus des Séances de l'Acad. d. Sci., Oct. 1888. (An account of the fauna of Samos.) Atti della Società Toscana di Scienze Naturali, Proc.-verbali, vol. v. 3 July, 1887, p. 272. (Letter addressed to Prof. Meneghini, in which Dr. Major shows the difference between the mammalian remains of Samos and tho of Kos.)
[5] Burckhardt, "Über Aepyornis," Pal. Abh., Jena, 1893, p. 21.
[6] Burckhardt, "Das Problem des antarktischen Schöpfungscentrums," &c., Zool. Jahrbücher, 1902, p. 26.
[7] Bull. Ac. Imp. Sc. St. Pétersbourg, vol. xviii. 1873.

is an egg of a *Struthio* has been proved by von Nathusius. Its geological age cannot certainly be determined because it was found floating in a river. Brandt supposes that it had been embedded in the bottom of the river and had been worked out by the water. The age of the strata forming the bed of that river is supposed to be that of the strata in which von Nordmann[1] discovered the mammalian remains in S. Russia (environs of Odessa), and therefore that of the breccia of Pikermi; but it may be much younger, because Nordmann[2] does not separate the Tertiary from the Pleistocene. In the paper above mentioned, he attributes the bone-beds of S. Russia to the "offenen Diluvium," and says that it has the same geological age as the bone-beds of the Val d'Arno. Therefore we have no evidence of the exact geological time during which a *Struthio* lived in South Russia, and the egg is in consequence of little importance in regard to this question. Moreover, it seems to me more than doubtful to assign this egg to the modern Ostrich, and "very likely to the species occurring at Samos," as is done in Nicholson and Lydekker's 'Manual of Palæontology' (p. 1228).

5. On a new Genus and two new Species of Earthworms of the Family *Eudrilidæ*, with some Notes upon other African Oligochæta. By Frank E. Beddard, M.A., F.R.S., F.Z.S.

[Received March 3, 1903.]

(Text-figures 35–38.)

The first set of specimens referred to in the following descriptions form a part of the collection in the British Museum; I am greatly indebted to the kindness of the Director for allowing me the opportunity of examining them. They belong to two species, both of which are undescribed. The first is a third species of the genus *Stuhlmannia*, which I call

Stuhlmannia michaelseni, n. sp.

I have examined so many individuals of this form of *Stuhlmannia*, and the agreement between them is so close, that I have no hesitation in regarding it as a distinct species, which I name after the founder of the genus, Dr. Michaelsen[3].

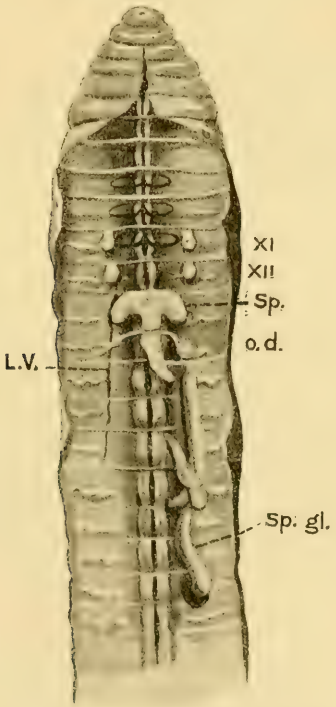
The worms were collected by Mr. S. L. Hinde in the Mt. Kenya district. There were thirty mature examples.

The general appearance and proportions of this new species are quite the same as in *S. variabilis*. The length reaches 100 mm. and the diameter 2–2·5 mm. The colour is a yellowish grey; the clitellum is greyer.

[1] Nordmann, in 'Jubilæum semisaeculare Fischeri de Waldheim,' Moscou, 1847.
[2] Nordmann, Paläontologie Süd-Russlands, 1858.
[3] JB. Hamb. wiss. Anst. vii. (1890), p. 24.

The setæ are strictly paired and the ventral pair of segment xvii. appear to be missing. The clitellum occupies segments xiv.–xvii. The median orifices of the spermatheca and of the spermiducal glands are very obvious, and frequently lie upon projecting papillæ. The spermathecal pore opens far back upon the xiiith segment. The male pore opens far back upon the xviith segment, or even intersegmentally (xvii./xviii.). The penial setæ can often be seen to protrude from it. Among the external characters, however, there is one which distinguishes the present species from its allies, and that is the total absence of the penial process of the body-wall. There was not the least trace of this organ observable in any of the individuals. It is true that this penis is not always to be seen in *Stuhlmannia variabilis*; but I do not think that it would be likely to be absent from thirty individuals selected at random; and this absence is therefore one of the reasons which lead me to create a new species.

Text-fig. 35.



Dissection of *Stuhlmannia michaelseni*.

xi, xii, segments eleven and twelve; *L.V.*, intestino-tegumentary trunks; *o.d.*, oviducal apparatus; *Sp.*, spermathecal sac; *Sp.gl.*, spermiducal glands.

The accompanying drawing (text-fig. 35) illustrates a general

view of the viscera seen on cutting open the body-wall in the dorsal median line. No such figure of the anatomy of this genus has been published up to the present; and it is convenient to show the relations of the different organs and their comparative sizes.

There are points in the anatomy of the genus *Stuhlmannia* which are illustrated by that drawing, and to which attention does not appear to have been called. The last pair of hearts lies in the eleventh segment, as in so many other Eudrilids, for instance in the genus *Polytoreutus*; and the septum which should separate segments xiii. and xiv. is nearly missing. I am disposed to associate this latter fact with the presence of the cœlomic sacs surrounding the gut, which may have been developed at the expense of the septum, as in *Eudrilus*[1], in which genus the corresponding septum is also much reduced. Another matter to which I would wish to direct attention, is the existence of intestino-tegumentary trunks, which have not yet been recorded in this genus. They are, of course, of wide occurrence among earthworms.

A further point of some little interest is visible in the sketch exhibited herewith. In my 'Monograph of the Oligochæta,'[2] I pointed out the existence of at least occasional asymmetry of the female reproductive organs shown in the presence of only a single receptaculum ovorum, that of the opposite side of the body being absent. In other specimens[3] I found precisely the same state of affairs. The species that I examined was, I believe, *Stuhlmannia variabilis*.

In the present species of *Stuhlmannia* there is exactly the same asymmetry, the receptaculum being only present upon one side, and that the right. Or, to be more accurate, the receptaculum is possibly present also on the left side, but is quite rudimentary, and, I imagine, functionless. The "Eitrichterblase," as Michaelsen has termed it, is present on the left side, and is simply a loop of the oviduct, the two sections of the tube running in close contact side by side; just opposite to it is a small spherical projection. A lumen is present in this, which is the rudimentary funnel, but the lumen is no wider than that of the oviduct elsewhere, and there is no question of any free communication with the body-cavity outside; there was no break to be detected in the muscular wall of this projection, which perhaps should be regarded as funnel + receptaculum.

A series of sections through the rudimentary funnel and the adjoining parts of the oviduct confirms the appearances displayed in a preparation mounted in glycerine. The rudimentary funnel (or funnel + receptaculum) is but a slight protuberance, which is traversed up to its very end by a blindly ending branch of the

[1] Beddard, "On the Gonad Ducts and Nephridia of *Eudrilus*," P. Z. S. 1902, vol. ii. p. 89.

[2] Oxford, 1895, p. 602.

[3] "On some Earthworms from British East Africa, &c.," P. Z. S. 1901, vol. i. p. 355.

descending limb of the oviducal loop, which constitutes the "Eitrichterblase" of Michaelsen. No communication between this short diverticulum of the oviduct and the general cœlomic cavity could be detected. Evidently, however, it is the forerunner of the funnel which opens into the fully developed receptaculum, or, possibly, of both. It is noteworthy that the oviduct is divisible into two regions. The section lying nearest to the spermathecal sac is of a wider calibre than that lying nearer to the external orifice. Furthermore, the lumen of this wider section is a straight tube, while the lumen of the narrower section of the oviduct is sinuous in its course within the muscular sheath. It is possible that the wide straight section is really to be looked upon as a greatly drawn-out funnel, drawn out by reason of the growth of the spermathecal sac.

The walls of the oviduct, as is the case with other Eudrilidæ, are very stout and muscular; and attention has already been called to the fact that part of the oviducal tube runs a sinuous course, independent, therefore, of its muscular covering. These facts, coupled with the conditions obtaining in *Eudrilus* [1], where the oviduct runs for a considerable space actually within the septum, lead me to consider that the muscular wall of the oviduct in *Stuhlmannia* may be a purely adventitious sheath, not belonging to the oviduct at all, but consisting chiefly of the otherwise missing septum between segments xiii./xiv. Its continuity with the receptaculum can at any rate be explained on this view, which is in any case not at variance with the other facts to which I have just called attention.

The present species, in correlation, it is to be presumed, with the entire absence of a penial process, does not possess the median unpaired bursa propulsoria which characterizes *S. variabilis*. In the former point possibly, but not certainly, it agrees with *S. gracilis*. Dr. Michaelsen states, only as a possibility, since he only examined two specimens, the absence of a copulatory process in *S. gracilis*; furthermore, a thickening of the integument of segment xv. appeared to him to be possibly intelligible as a not fully developed penis. With regard to the presence or absence of a bursa propulsoria he is silent. *Stuhlmannia michaelseni*, however, cannot be confused with *S. gracilis* by reason of the characters of the penial setæ. They are provided at the end with a row of sharp denticles on either side as in *S. variabilis*. In short, I think that a case has been made out for the creation of a new species of this genus *Stuhlmannia*.

Bettonia lagariensis, n. g. & sp.

Of this apparently new genus and species I have examined but a single specimen, complete and sexually mature. It measures 90 mm. by 4–5 mm. in breadth. The colour is bluish violet. It

[1] Beddard, "On the Gonad Ducts and Nephridia of *Eudrilus*," P. Z. S. 1902, vol. ii. p. 89.

was collected by Mr. Stuart Betton, at Lagari, British Central Africa.

The prostomium is continued by grooves over about half of the buccal segment.

The setæ are wider apart in the case of the ventral couples than in the case of the lateral.

The limits of the clitellum are a little obscure; it appears to embrace segments xiv.–xvii. inclusive.

The chief, indeed practically the only, reason which leads me to separate this Eudrilid generically, is the condition of the reproductive apertures. The rule in the family is that the apertures of the sperm-duct and of the spermathecæ are unpaired and median in position.

Text-fig. 36.

Ventral surface of *Bettonia lagariensis*. ♀, spermathecal pores; ♂, male pore.

There are, however, a few exceptions, such as *Eudrilus* itself, and an apparently close ally of the present genus, viz. *Eminoscolex*. *Bettonia* offers a third arrangement of the reproductive pores.

The spermathecal pores are paired, while the male pore is single and median (text-fig. 36, p. 214).

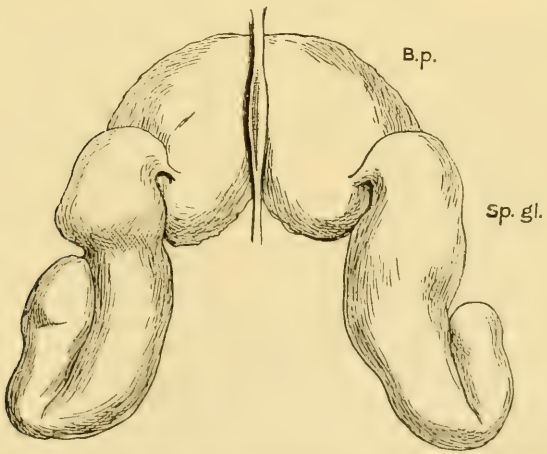
The two former pores are upon the boundary line of segments xii./xiii.; each is somewhat eye-shaped in contour and corresponds exactly in position to the outermost of the ventral couple of setæ.

The single and median male pore lies on the boundary line of segments xvii./xviii. It is very large and conspicuous, with radially folded margins, indicating, perhaps, the possibility of the extrusion of the bursa propulsoria.

The internal organs, unfortunately, were much softened, and therefore the female reproductive apparatus was rather difficult to decipher. The nature and relations of the other organs of the body were not so difficult to ascertain.

As in many, if not in all, Eudrilidæ, the last pair of hearts occurs in segment xi. In front of these were four distinct pairs. The dorsal vessel is single throughout. I have not been able to study the alimentary system in detail, but I have ascertained that the present species is a member of the section Eudrilacea by virtue of the existence of an unpaired ventral median alimentary gland in segment x., which showed on a microscopical examination the usual laminate structure of these glands, not at all to be confounded, even in a badly preserved specimen like the present, with the totally different though corresponding organs in the other subfamily of the Eudrilidæ. There are also a pair of these glands in segment xiii., of an oval form, which contain abundant crystals, such as are met with in other genera.

Text-fig. 37.



Termination of the male efferent apparatus of *Bettonia lagariensis*.
B.p., Bursa propulsoria; *Sp.gl.*, spermiducal glands.

The only conspicuous parts of the male generative system are

the sperm-sacs and the terminal apparatus, which opens on to the exterior in the xviith segment. The sperm-sacs are in segments xi. and xii., and occupy a considerable space in those segments. They are simple, solid, sac-shaped structures, not racemose in form.

The spermiducal glands are paired. Each of them (see text-fig. 37, p. 215) is shortish and rather thick, tapering somewhat towards the tip. The last third of the gland is bent forward and lies above, parallel to and in contact with the anterior section of the gland. This arrangement occurred on both sides of the body. Each gland is sharply constricted at its opening into a large median bursa propulsoria lying below the ventral nerve-cord. This latter sac, however, presents obvious signs of having been produced by a fusion of two sacs; for posteriorly it is completely double. It is into each of these posterior lobes that the spermiducal glands open.

My description of the female apparatus must unfortunately be incomplete. The organs, as already stated, are paired. The spermathecæ, near to where they open, have very thick muscular walls; and this region at least is enveloped in a cœlomic sac, as is the base of the spermatheca in the species of *Pareudrilus* (?), with which I deal later in the present communication (see below). How this cœlomic sac is otherwise related to the spermatheca and to the receptaculum ovorum I am unable to state. The latter organ presents no noteworthy peculiarities, and the oviduct leads from it to the exterior, on the fourteenth segment.

On a Species of Pareudrilus.

I believe that a number of individuals belonging to this genus, which were collected by Mr. Crossland, may represent a new species. But I am unable to speak with absolute certainty on the matter, since the material was not in good order for investigation, and since the specimens of *P. papillata* examined by Michaelsen [1] were likewise much softened by evaporation of the alcohol; if the worms upon which I report here are not referable to *P. papillata*, then the species is unquestionably new.

But whether the species be new or not, I have something to add to what is known about the structure of this genus.

The dimensions of my specimens agree apparently with those given by Michaelsen for his species. The length was some 100 mm. and the diameter about 3 mm. The dark purple colour, turning to yellow below and in the clitellar region, is like that of my *Pareudrilus stagnalis*. The setæ are closely paired, and I observed a tendency in the neighbourhood of the genital pores for one seta of a pair to be lost or not developed. I do not refer to a mere dropping out; on examining the cuticle, occasionally no pore was to be noticed in the place where such a pore (through which the seta is extruded) should be. The irregularity of this state of affairs

[1] "Die Regenwürmer Ost-Afrikas," in Deutsch-Ost-Afrika, p. 11.

does not incline me to describe in detail the cases observed, which were, moreover, not many. I can confirm Michaelsen's statement that there are no genital or any specially modified setæ in any region of the body.

In the external sexual characters I find some little differences from the description of Michaelsen, and it is partly on this account that I am disposed to regard my specimens as belonging to a new species. The clitellum is perhaps a little more extensive, xiii.–xviii. or even xix.; but that is a slight difference. I find that the pores of the paired spermathecæ are situated definitely on the border-line of segments xiv./xv. and not upon xiv. They are, however, in the line of the ventral couple of setæ. On the other hand, I agree with Michaelsen in placing the pores of the spermiducal glands upon segment xvii. just in front of the ventral setæ of that segment. As to the location of the genital papillæ, Dr. Michaelsen and I have not found the same conditions in the specimens studied. In my specimens, the constant rule appears to be the presence of two pairs of papillæ of which the most anterior are on segment xvii., just behind the ventral setæ but on a line with the outermost setæ of the couple; on the following segment, the xviith, there is a precisely similar pair also behind the ventral setæ, but in this case corresponding to the innermost seta of the couple.

The papillæ are fairly conspicuous, and are to be noted upon the cuticle when stripped off. The area is slightly raised and is studded with the mouths of large glands. Corresponding to the papillæ internally, are glands to which I shall recur in describing the anatomy. These papillæ were never absent.

I could discover no nephridial pores; but I imagine that this species, like *Pareudrilus stagnalis* and some other Pareudrilacea, will turn out to possess a ramified system of nephridial end-tubes in the integument. In any case the nephridia, viewed internally, appear to be paired structures. As to the alimentary tract, I find a gizzard far forward, in the sixth or seventh segment, and I have not been able to find calciferous glands. The last heart is in xi. The funnels of the sperm-ducts are in x., xi. The two pairs of sperm-sacs, in xi., xii., are tongue-shaped.

As to the female generative system, my observations do not altogether agree with those of Michaelsen; but it is no disparagement to that excellent and accurate observer to suggest that the condition of his specimens may possibly have led him into some slight error. Otherwise I must place my specimens not only in a new species, but in a new genus. The ovary I have not been able to find at all. This in an Eudrilid is not of course surprising; for as a rule the ovary disappears early, having transferred its cells to the egg-sac. On the other hand, while it is unlikely that I could have missed so conspicuous an object as the large ovarian sac figured by Michaelsen, it is equally unlikely that he was misled by bulging septa or other structures into stating the presence of such a sac communicating with the egg-sac. It seems to me

therefore to be possible that, after all, in spite of undoubted resemblances, Michaelsen and I have examined different species and indeed different genera.

The female organs of the species which I have examined show a number of not uninteresting features. The two most salient parts of that system, which are visible on a dissection, are the two spermathecæ and the egg-sacs. The spermathecæ are sausage-shaped, and distinctly divisible into two regions. The proximal part, *i. e.* that nearest to the external orifice, is strongly muscular, and indeed is enveloped with stronger muscular bands than is the bursa propulsoria of the spermiducal gland. Its epithelium is perfectly continuous with the general epidermis of the body-wall, and it has every appearance of being formed as an ingrowth from the exterior. The distal region of the spermatheca has very thin muscular walls, much thinner than the walls of the glandular part of the spermiducal gland.

The interior has an epithelium which is raised into folds. I cannot speak of the histological characters of the cells, as the material was not sufficiently good. There is a very close resemblance, on a superficial view, between this spermatheca and the spermiducal glands. Indeed, on a cursory inspection, they might be taken for consecutive pairs of either spermathecæ or spermiducal glands. The next most obvious part of the female reproductive system is a very large mushroom-shaped body closely adherent to the septum dividing segments xiii./xiv. This body is stalked, and appeared, on dissection, too large to be identified with a receptaculum ovorum (or egg-sac). Nevertheless it is the egg-sac, and by virtue of its large size it appears to be precisely like the egg-sac of *P. papillata* described by Michaelsen. On a closer inspection, a fine tube, apparently leading from the stalk of the egg-sac to the muscular part of the spermatheca, was apparent; this seems to correspond to the narrow tube (*sg.*) figured by Michaelsen.

A series of longitudinal sections through the body showed more accurately the relations of these diverse organs to each other. I find that the spermatheca is entirely independent of the rest of the female apparatus, and that its cavity does not communicate with the narrow tube arising from the egg-sac. That narrow tube exists, as I have already mentioned; but on reaching the base of the spermatheca, *i. e.* the muscular end portion, it dilates into a sac which entirely surrounds the muscular part of the spermatheca, but does not, so far as I could ascertain, open into it anywhere. The conditions, therefore, are those of such a genus as *Hyperiodrilus* or *Heliodrilus*, where a true spermatheca is invested by a cœlomic sac. Now, though the difference may appear to be slight, I am disposed to think that it is important, and that a spermatheca which has no communication with the egg-conducting apparatus is essentially different from a spermatheca which has such a communication. It seems to me, for example, to be wrong to compare the spermathecal sac of *Lybiodrilus* or *Stuhlmannia* with

the spermatheca of *Heliodrilus*. For this reason I cannot agree to Michaelsen's placing of my genus *Alvania* within the genus *Hyperiodrilus*. The former has a true spermatheca, homologous with that of other non-Eudrilid earthworms, while the latter has not. This also is the case with the genus or genera with which we are dealing now. *Pareudrilus stagnalis* has a spermathecal sac which communicates with the cœlomic sacs envolving the ovary; "*Pareudrilus*" *papillata* has not. It is possible, therefore, that we should revive Michaelsen's *Unyoria* for the latter species. The stalk of the egg-sac, as might be expected, lodges the funnel of the oviduct, or, to speak more accurately, the greater part of the funnel. The exact conditions obtaining are the following. In a series of sections it may be seen that the narrow tube communicating with the cœlomic sac surrounding the proximal end of the spermatheca runs forwards and opens into the cavity of the xiiith segment by a wide orifice; its walls are therefore continuous with, and no doubt developed from, the septum bounding segment xiii. posteriorly. The upper "lip" of the ostium is covered by the cubical cells of the oviduct, which here opens freely into the cavity of the xiiith segment. Further on in the series of sections, the mouth of the sac surrounding the spermatheca is closed, and the tube opens into the egg-sac through a wide tube which is entirely lined by the cells of the oviducal funnel; these are, of course, perfectly continuous with those cells which lie in the xiiith segment. The part of the oviducal funnel which lies in the xivth segment appears to be divided into two, and to open by as many mouths into the huge egg-sac, which is so kidney-shaped as to be nearly divided into two sacs; I cannot pretend to an accurate description of the funnel and its various foldings. It is clear, however, that the conditions which obtain are those of the more typical Earthworms, where the funnel opens partly freely into the xiiith segment and is partly reflected so as to open within the egg-sac. Now, the simpler forms of Eudrilidæ, such as the genus *Eudriloides*, are distinguished by the fact that the ovary is unenclosed in any sac, and that the funnel of the oviduct opens precisely as has been just described in *Pareudrilus papillata*. On the other hand, in the more complicated forms, such as *Stuhlmannia*, the sacs containing the ovaries envelop also the oviduct-funnel and communicate with the spermathecal sac. The species which forms the subject of the present remarks is plainly intermediate between these two extremes; and for that reason, as I think, deserves generic separation from *Pareudrilus*.

§ *On the Spermatophore.*

The spermatophores of the Eudrilidæ have not been much studied, and, so far as I am aware, are known only in the genera *Stuhlmannia* and *Polytoreutus*, in which I have myself described them. Many, if not most, of the individuals of the present species which I examined had a single spermatophore in both the spermathecæ.

As will be seen from the accompanying drawing (text-fig. 38), the spermatophore consists of a globular swelling followed by a long thin tube. The sperm, which appears blackish in glycerine preparations, is limited to the spherical or nearly spherical receptacle at the distal end of the case. The spermatophore, as will be

Text-fig. 38.

Spermatophore of *Pareudrilus* sp.

also apparent from the figure referred to, is of an elegant form, not precisely corresponding to that of the spermatheca in which it lies. The swollen and globular receptacle of the sperm is not more than one-third of the length of the "stalk," which reaches down to the very mouth of the spermatheca. At its termination the walls of the spermatophore project in a ring-like fashion; a state of affairs exactly recalling the spermatophores of the Tubificidæ, and of the genus *Stuhlmannia* among the Eudrilidæ. No doubt the shape is due to a moulding upon the walls of the spermatheca; but the state of preservation of the specimens does not enable me to give details. The walls of the spermatophore appear to be firm and thick, and rather brittle in consistency. In teased preparations the rupture of the stalk was invariably a clean fracture. The walls are fibrous in appearance, and of the usual pale brown colour that is generally associated with chitinous membranes. The extremity of the tube, *i. e.* that which is nearest to the mouth of the spermatheca, is open; the other end is quite blind. The

shape of the whole spermatophore is sufficiently elucidated by the drawing referred to.

§ *Note on the Clitellum of* Alma stuhlmanni, *and on a possibly new species of the genus* Alma.

I believe that a note by myself [1] upon the clitellum and spermatophores of a West-African species of the genus *Alma* is the first record of the extent of the clitellum in that genus. Like other aquatic forms, *Alma* seems to be characterised by a seasonal development of the clitellum; and hitherto, with the exception just mentioned, no one appears to have seen or at least described this organ in that Geoscolecid. In the species to which I have just referred, the clitellum was found to extend from segment xlv. to lxxxv., a position which is quite unlike that found in any other Geoscolecid and present only in a few Lumbricids. This is an additional reason for associating the genus *Alma* more particularly with *Criodrilus*, as is done by Michaelsen; for both these genera, though referable to the family Geoscolecidæ, have many points of kinship to the Lumbricidæ. As, however, up to the present time, but one species of the genus *Alma* has been described in the fully mature condition, it is possible that the position and extent of the clitellum characterising that species are not normal but exceptional in the genus. Therefore I do not hesitate to describe the conditions occurring in a second species of the genus, which I owe to the kindness of Mr. Cyril Crossland, who collected specimens on the shore of Victoria Nyanza, among weeds cast up by the waves. I have two fully mature examples of a species which I believe to be identical with Dr. Michaelsen's *Alma stuhlmanni*. The dimensions, however, are rather less; only one of the two examples was quite intact—the other had lost the hinder end of the body; in the complete example, measurements showed a length of 120 mm. The other might have been slightly longer, as it was rather thicker. In both, the penial appendages were rather longer than those of the original specimens described by Michaelsen. I found them to be 10 millimetres long; in one example the two were unequal in size, one penial appendage only measured 6 mm. The structure of these appendages is usually characteristic of the species. The worms which I have examined agreed in almost every detail with the description of *A. stuhlmanni* as given by Michaelsen [2].

I may remark, however, that there were only two setæ at the free end of the penial process, and, indeed, one of these had dropped out. The two papillæ upon which these setæ are placed were partly encircled by a horseshoe-shaped region of specially glandular epidermis, which was conspicuously marked out from the rest of the integument covering that process. It is conceivably this region which secretes the spermatophore. In addition to this,

[1] "On the Clitellum and Spermatophores of an Annelid of the Genus *Alma*," Proc. Zool. Soc. 1901, vol. i. p. 215.

[2] "Die Regenwürmer Ost-Afrikas," in Deutsch-Ost-Afrika, 1896, p. 4.

I fancy that the single papilla at the base of the penial process is rather nearer to the base than is figured by Michaelsen, and much nearer than in the West-African form, and, moreover, it appeared to me to be not symmetrical in its position. The clitellum was not seen by Michaelsen at all. In my specimens the clitellum occupied the same segments; but, as in the species described by myself from Western Africa, that generative region was somewhat undefined in its beginning and ending. The greatest number of segments referable to the clitellum in the West-African species are from xlv.–lxxxv.; but the clitellum was only fully developed upon segments xlvii.–lxxxii. Its general appearance was precisely like that of the species which I have just mentioned. In the present species—and the observations apply to more than one specimen, and are therefore all the more reliable as an expression of normal conditions—the clitellum was much shorter, only extending from segments xl.–lxxi. This rather leads me to the inference that the species with which I am concerned here is in reality different from that which I described from McCarthy Island on the Gambia, and referred to *A. stuhlmanni*. The present worm is undoubtedly *A. stuhlmanni*; and it seems to be necessary, on account of the difference in the clitellum, to use another name for the West-African form. I would propose, therefore, to call the latter *A. budgetti*. It is, however, clearly a very close ally of *A. stuhlmanni*. It is interesting to note that the species of this genus go more or less in couples. The East-African *A. nilotica* corresponds to my *A. millsoni* from West Africa, while *A. stuhlmanni* seems to be nearest to the form which I propose to name *A. budgetti*. At present more information is wanted about *A. emini*; but it appears to be formed rather after the plan of *A. millsoni* and *A. nilotica*. For in those species there are special setæ on the penial processes, while in *A. stuhlmanni* and *S. budgetti* there are setæ of the same pattern as those on the body generally.

March 17, 1903.

G. A. Boulenger, Esq., F.R.S., Vice-President, in the Chair.

The Secretary exhibited, on behalf of Prof. Newton, F.R.S., three photographs of the White Rhinoceros (*Rhinoceros simus*), sent to him with the following letter by Mr. C. R. Saunders, C.M.G., Chief Magistrate and Civil Commissioner in Zululand:—

Eshowe, Zululand,
6th January, 1903.

Dear Sir,

I received a letter from you in August 1900, following on an account, written by me in 'The Field,' of an interview I had with White Rhinoceroses about that time. I did not answer your letter at the time, hoping I should be able before long to send you a photograph of the living animal. This, however, I

have not yet been able to procure, although I visited the reserve in which they lived for this special purpose last winter. Their traces were abundant, but my time was limited, and they could not be found. There are, I believe, about ten of these animals living in that reserve, and I do not despair of yet obtaining a photograph of them in life, in which case I shall be pleased to send you a copy of it.

Early last December two of the animals (both bulls), one a very old one and the other not full-grown, strayed out of the reserve into one of the native locations and were killed. I obtained three photographs of one of them, the old bull, taken by an amateur two or three days after it had died. I am forwarding by the same mail as this a copy of each of these photographs, which you are welcome to, and which, I think, demonstrate the fact that they were taken from a specimen of the White Rhinoceros, although the carcass was a good deal distended.

The killing of these two Rhinoceroses was most unfortunate. They suddenly appeared among some native kraals, and the men went out and attacked them with spears. The young one was killed outright; that of which the photograph was taken travelled a long distance after being wounded, and was not found until some days had elapsed.

Yours faithfully,

Alfred Newton, Esq. C. R. Saunders

As these photographs were probably the only representations

Text-fig. 39.

Recently-killed *Rhinoceros simus*, adult ♂. Dec. 1902.

ever taken of this animal in the flesh, it seemed well worth while reproducing two of them (text-figs. 39, 40).

Text-fig. 40.

Recently-killed *Rhinoceros simus*, adult ♂. Dec. 1902.

Mr. Oldfield Thomas exhibited the skin of a Chinese Monkey, which had been obtained from a hunter by Mr. Henry Brelich, and presented by him to the National Museum. It appeared to represent a new species, the third known, of the remarkable genus *Rhinopithecus*, and was described as follows :—

Rhinopithecus brelichi, sp. n. (Plate XXI.)

Size very large, apparently larger than either *R. roxellanæ* or *R. bieti*; for the skin, though that of a female, is as large as the male of either of the other species. Fur not abnormally elongated in any region, the longest being on the flanks, where the hairs may attain to about 90 mm. in length ; those of the back 50–60 mm., and those across the shoulders 70–80. General colour of back glossy slaty grey, the hairs grey to their roots, with shining tips. A prominent oval white patch, 5 inches long by 2 broad, present in the middle line between the shoulders, its hairs white to their roots. Crown suffused with yellowish, its hairs yellow at base, whitening terminally, but with broad black tips; hairs of cheeks

J.Smit del.et lith.

Mintern Bros.imp.

RHINOPITHECUS BRELICHI.

yellow with black tips; nape between the yellowish crown and the white wither-patch pale brownish with black tips to the hairs; neck both on sides and below blackish grey, the hairs dull whitish basally, with black ends. Ears white, markedly contrasting with the head. Front of shoulders and inner aspect of forearms deep yellow, which shades into whitish along the under aspect of the latter, and contrasts markedly with the dark slaty of the outer side of the forearm, this colour darkening to black on the wrists. (The hands are lost in the specimen, but are presumably black.) Hind limbs light greyish, more or less suffused with yellow behind and blackish in front, but the colour contrasts are not sharp and defined as they are in the other species. Belly uniformly grey (about grey No. 5 of Ridgway). Tail very long, conspicuously longer than in the other species, its hairs, which average about 40 mm. in length, curiously curved on each side downwards and away from the centre line, along which there is an irregular parting; in colour the tail is black throughout except at the extreme tip, where there is a small white pencil; on each side of its base there is a small yellow patch, outside of which there is a blackish line passing round across the anal region: but owing to the condition of the skin, the exact situation of these lines and patches is not quite certain.

Approximate dimensions of the type, measured on the skin, which has been made up from a flat native pelt:—Head and body 730 mm., tail 970 (with hairs 1040).

Habitat. Mr. Brelich states that, "as far as I could gather, this monkey inhabits a range of mountains known as the Van Gin Shan Range, about 108° E., 29° N., in the north of the province of Kwei-chow, Central China."

Type. Female. B. M. No. 3.3.14.1. Collected and presented by Henry Brelich, Esq.

This magnificent Monkey, one of the largest in the world apart from the anthropoids, is a very remarkable discovery, and one on which we may congratulate Mr. Brelich, who obtained and sent it to the Museum on the suggestion of Mr. Herbert Ingram, himself a frequent contributor to the National collections.

As may be seen from the above description and from the figure (Pl. XXI.), the differences between this monkey and its only near allies are so numerous as to render any detailed comparison unnecessary. Good figures have been given of *R. roxellanæ* by Milne-Edwards[1] and De Winton[2], and of *R. bieti* by Milne-Edwards and Pousargues[3].

Mr. Oldfield Thomas also exhibited adult and young examples of a Bush Duiker, which had been sent to the British Museum by Mr. F. W. Isaac, from Eldoma Ravine, British East Africa.

[1] Rech. Mamm., Text, p. 233, Atl. pls. xxxvi. & xxxvii. (1874).
[2] P. Z. S. 1899, p. 572, pl. xxxi.
[3] N. Arch. Mus. (3) x. p. 121, pls. 9–12 (1898).

It appeared to belong to a new species allied to the Congolese *Cephalophus weynsi* Thos., and was described as follows:—

CEPHALOPHUS IGNIFER, sp. n.

Size medium. Fur close, fine and glossy, hairs of back about an inch in length. General colour of back bright rufous or bay (nearest to ochraceous-rufous of Ridgway), darkening forwards on the neck and shoulders to dull brownish. Forehead mixed rufous and black; crown and occiput bright rufous like back, coronal tuft a deeper and more chestnut or vinaceous rufous. Hairs of occiput reversed upwards to the crest as usual, those of nape all directed backwards. Muzzle blackish; lips and chin white; ears dark brown behind, with white edges and inner surfaces. Throat rufous. Belly brown mesially, grading into rufous laterally. Inner side of forearms, inguinal region, and inner side of thighs white. Outer side of forearms and thighs rufous; feet brown, darkening almost to black above the hoofs. Tail rufous above, white below, proximally, with a mixed brown and white terminal tuft.

Skull of normal proportions; premaxillæ just reaching nasals; frontal convex as usual; posterior palate variable, that of the male cut out some way in front of the lateral notches, while in the female the median notch is posterior to the lateral ones.

Horns laid back just in the line of the face, those of an adult male 98 mm. long, with a basal diameter of 31 mm.; the same dimensions in an immature female 49 and 20.

The young specimen (skull 105 mm. long, the last milk premolar only just up) is nearly black all over, the coronal region and the posterior back alone being rufous.

Dimensions of the type, an adult male, measured in skin:—

Head and body 810 mm., hind foot, with hoof, (c.) 240, ear 81.

Skull—basal length 162, greatest breadth 79·5, muzzle to orbit 94, nasals 73 × 32; palate length 97; length of upper tooth-row 53, of three upper premolars 23·4.

Hab. Eldoma Ravine, British East Africa, alt. 7200 feet.

Type. Male. B.M. No. 2.11.17.6. Collected and presented by F. W. Isaac, Esq. Three specimens.

Native name "Meindet."

This Duiker is allied to *C. weynsi* of the Eastern Congo and *C. johnstoni* of Toro by its colour and general characters, but differs from them by the hairs of its nape being all directed backwards in the usual way. *C. harveyi* of Kilima-njaro, also a member of this group, has a blackish forehead and no chestnut coronal tuft.

The following papers were read:—

1. Observations and Experiments on Japanese Long-tailed Fowls. By J. T. Cunningham, M.A., F.Z.S.

[Received January 1st, 1903.]

(Text-figures 41 & 42.)

The enormous length of the tail-feathers in Japanese "Long-tailed Fowls" has been known to zoologists in this country for many years from the stuffed specimens in the hall of the Natural History Museum in London. These specimens were figured by the late G. J. Romanes in his 'Darwin and After Darwin,' Part I., published in 1892. The figures represent fairly accurately two males of the breed, but the females are not represented at all, unless by indistinct figures in the background; and the accessories, instead of being drawn from those actually present in the Museum case, are entirely imaginary, showing the birds in a state of perfect freedom in open country, a state which they never enjoy in Japan. Romanes's figures are among a large number given as "typical proofs of the efficacy of artificial selection"; and it is the object of the present paper to show that this involves an assumption, with regard to this particular breed, which is by no means justified by the facts.

The tails of the male specimens in the National Museum are 6 to 9 feet in length, that is to say, the longest feathers are of that length. I have endeavoured, but without success, to obtain information concerning the history of these specimens. I believe they were reared in Japan, and they were probably sent from that country after death, either as skins or as stuffed specimens. There are some female specimens also, but in these the tails are scarcely longer than in the hens of ordinary breeds.

The breed has been known to poultry-fanciers for a considerable time, and the following is the account of it given in 'The Book of Poultry' by Lewis Wright, published in 1885:—

"About the year 1878 there appeared in Germany, and a year or two later in England, fowls imported from Japan, whose principal peculiarity consisted in an immense length of tail and hackle-feathers. Some of these were exhibited as Yokohamas; others, said to be superior in these points, were called Phœnix fowls. The tails of these specimens averaged about a yard in length, and the general appearance was not only that of a Game-fowl, but all the colours were Game colours, Whites, Piles, Duckwings, and later a few Black-Reds. The long plumage was, however, unique, and a fair idea of it may be gathered from the illustration.

"Correspondence in the poultry journals brought out the fact that such birds had been occasionally exhibited as Japanese game so far back as about 1872. But it further appeared that in the Japanese Great National Museum at Tokio there were preserved two specimens of an allied race in which the tail-feathers measure

13½ feet and 17 feet respectively, and a feather has been actually sent to France which measures 2 metres 85 centims. in length (say 9½ feet). In 1884 Mr. Gerald Waller, of Twywell, imported a pen of these birds; and from his statements we gather that they are known in Japan as Shinowaratao, Shirifuzi, or Sakawatao fowls and various other names. He says the very long-tailed ones are kept in high, narrow cages, always sitting on a perch covered with straw-rope, with no room to turn or get down, but with a food- and water-tin at each end of the perch. Three times daily they are lifted down for a few minutes' exercise, their tails being carefully rolled up in paper cases to keep them from injury. The Japanese state that a tail has been measured 23 feet in length, and that the birds only moult the tail once in three years. This last statement is highly interesting. It is obvious that if a tail 23 feet long were grown in one year, it must be at the rate of nearly three-quarters of an inch per day; and though Madame Bodinus states that she could see the tails grow daily, it is difficult to realise this; but experience will soon decide the point. The birds which have reached Europe have never yet exceeded 5 or 6 feet in length of feather, which is not beyond the possibility of a single season, though it appears of an enormous length. The saddle-hackles of Mr. Waller's birds are 16 inches in length; but it is manifest that such enormous feathers as reported from Japan could never be preserved under the ordinary conditions of an English poultry-yard. The feathers are not only long but extremely narrow and flexible, trailing low after the birds."

Mr. Wright does not mention the comb, but the illustration which he gives represents the male bird with what is called a pea-comb of small size and with small wattles, whereas the specimens in the National Museum have single vertical serrated combs and large wattles. The pea-comb is a rounded mass, with small rounded tubercles projecting from it.

Mr. Frank Rice, of Acton, Suffolk, who breeds Yokohamas, gives in his circular the same illustration which appears in Mr. Wright's book, and which therefore is certainly not a new figure from a living specimen. But in his description he states that the head should be neat and small, with evenly-set pea-comb. It would thus appear that the long-tailed fowls comprise varieties which differ in comb as well as in colour, though they seem to be all similar in the excessive growth of the tail, and probably are all grown in Japan under the same artificial treatment.

The principal purpose of this paper is to discuss the causes by which the elongation or excessive growth of the tail has been produced. About two years ago, Prof. Lankester, in a letter to 'Nature,' referred to the specimens in the Museum of which he is Director as "a magnificent sport," comparing their exceptional character to what is called genius in human beings. On the other hand, in the 'Dictionary of Birds' by Newton and Gadow, article "Feather," the length of the tail-feathers is attributed to

continuous growth, and it is stated that the moult is checked or prevented by some means unknown to Europeans. We have seen that in Wright's book the statement is cited that the feathers are only moulted once in three years, but this might be a congenital peculiarity, whereas the expression used in the 'Dictionary of Birds' implies that the moult is prevented by artificial treatment.

Very definite statements on the question are made in a paper by Mr. Basil Hall Chamberlain ("Note on a Long-tailed Breed of Fowls in Tosa," Trans. Asiatic Soc. Japan, vol. xxvii. 1900), for my knowledge of which I have to thank Mr. Frank Finn. Mr. Chamberlain made enquiries on the subject in the country from which the breed is obtained, and where presumably it originated, but nevertheless his statements are based on the assertions of breeders and not on any investigations of his own. The following is a summary of his paper:—

The origin of the breed is not known, but it is believed to be at least a hundred years old. It has been produced simply by selection of the best specimens; one highly-prized variety, the Haku, was produced in this way within the last few years.

The proper general name for the Long-tailed fowls is Shinowara-tō, derived from the village of Shinowara in the province of Tosa, east of Kochi the capital. Some are still bred in that place, but most now in Kochi itself, whence the majority are exported to Kobe and some of the finest to Tokio, but the very finest are retained by the producers.

The following varieties were described to Mr. Chamberlain:—Shira-fuji: white head- and body-feathers, tail black as in the other varieties. He saw one specimen of this two years old, and measured its tail-feathers, which were $7\frac{1}{2}$ feet long. Another specimen, fourteen months old, had tail-feathers 4 feet long. Others have black bodies. Another variety is the Haku, white all over with yellow legs; another, Totenko, has red neck- and body-feathers; another, Dokiri, has reddish colour mixed with the white of the body. All these except the Haku have black tail-feathers.

As great a length as 18 feet has been reached in the tail-feathers, but even 12 feet is a rarity. From 7 or 8 to 11 feet is the usual length. The feathers grow about 4 inches a month, and continue to grow while the bird lives, which may be eight or nine years. The beautiful body-feathers growing from the shoulders reach a length of 4 feet. (*Note*.—This evidently refers to the saddle-hackles, which grow not from the shoulders but from the top of the rump.)

Some of these saddle-hackles may fall off in moulting, but the tail-feathers never do so. He saw the birds in October 1898 when moulting, and only the ordinary feathers were gone or going, not the long ones.

He also saw the hen, which was a handsome bird, distantly reminding one of a hen-pheasant, with fawn-coloured breast and white quill to the delicately-coloured feathers of the back. She,

too, has longer tail-feathers than an ordinary hen, sometimes as long as 8 inches. One, or at most, two hens are allowed to each breeding-cock. The latter's tail-feathers are cut to allow of his walking about freely. He lives a little longer than the others which must be kept shut up; but all are hardy, bearing both heat and cold. The ordinary number of long tail-feathers is 15 or 16, some cocks have as many as 24.

The tail-feathers must not be wound up, as people ignorantly do away from Kochi, but must always be allowed to hang free; for which reason the cocks are kept in high, narrow cages, quite dark except at the top, for light at the bottom would attract them. When the tail-feathers become too long and touch the ground in the cage, a bamboo is put a little way back so as to form an arch and make more distance. The birds sit all day on a flat perch 3 inches wide, and are only taken out once in two or three days and allowed to walk about for half an hour or so, a man holding the tail all the while to prevent its getting torn or soiled.

The high, narrow cages may be made of any wood; they are $6\frac{1}{2}$ feet high, 3 feet deep, and 6 inches wide. The wonderful feathers both on tail and body come from quills much stouter than any possessed by ordinary fowls.

The price in Kochi was 15 dollars for a cock with tail under 10 feet, 25 dollars over that length.

There is absolutely no artificial method of making the feathers grow. All is done by selection. Any failure is due to not having a hen or parents of the proper breed. Also one must know how to treat the birds.

At Kobe in November 1898 Mr. Chamberlain saw three specimens, one with tail-feathers $13\frac{1}{2}$ feet long. He also saw a splendid white tail $10\frac{1}{2}$ feet long, which had been pulled out from a white bird owing to its falling off its perch and fluttering about. The bird was five years old, and the feathers were growing again. The fancier said that the feathers in young birds grow about 4 inches a month, in older birds more, up to 7 inches a month.

Two photographs are given with the paper, but no reference to them is made in the text. The tails are very long, but there are no long feathers from the shoulders, only tail- and saddle- or rump-hackles.

It is evident that Mr. Chamberlin, although his observations are of considerable value, was not an experienced naturalist, and that he is simply reporting what he was told. He says nothing about the combs of the fowls he saw. With regard to his assertions about selection as the sole means by which the breed has been produced, it is to be noted that he is evidently referring in the case of the Haku chiefly or entirely to colour. The Haku is a white variety, and Mr. Rice, above mentioned, also has a strain of this colour. Nearly all domesticated birds and animals vary in colour, and nothing is easier than to separate a white variety in fowls, horses, pigeons, dogs, &c. These fowls, like others, vary in colour; and the question before us now is not the separation of

colour varieties, but the excessive length of the tail which occurs in all the varieties. Mr. Chamberlain states that a specimen fourteen months old had a tail 4 feet long. At the rate of 4 inches a month, this would mean a period of growth of twelve months, and therefore the chickens must have begun to acquire their permanent feathers at two months of age, and the feathers must have grown without intermission afterwards. This is perhaps not impossible, but according to my observations, recorded below, it is very improbable. It may further be pointed out that the statement "there is absolutely no artificial method of making the feathers grow," is difficult to reconcile with that which follows it, "also one must know how to treat the birds," unless proof is offered that the artificial treatment has no effect on the growth of the feathers.

The birds in my possession, which have formed the subject of my own observations and experiments, were descended from a pair which were imported direct from Japan by Mr. John Sparks, of London, and purchased by Mrs. J. C. Williams, of Caerhayes Castle, Cornwall. Before proceeding to my own observations, I wish to discuss the question whether the moult occurs in the specimens kept in this country, and also some evidence I have obtained as to specific treatment of the feathers. We have seen in Mr. Wright's account that the feathers of birds in this country had not been known to exceed 5 or 6 feet in length. This does not throw much light on the question of the moulting, because it may be that, the birds not being kept on perches as in Japan, the feathers get broken when they have reached a considerable length. I enquired of Mr. Rice what his experience was, and he replied that his birds usually moulted their tail-feathers each year, but he had had some cocks omit this operation in their second year. He said that his cockerels at eight months of age had tails from 2 ft. 6 in. to 3 ft. 6 in. in length, and that he had one cock, three years old, that had a tail $5\frac{1}{2}$ feet long.

Mrs. J. C. Williams was also kind enough to answer my enquiries. She informed me that the original male bird which she obtained from Mr. Sparks had a tail just 5 feet long. At first its plumage suffered from the change of climate, but in 1901 its tail was considerably better than it had been. (The length at this time was not stated.) She had a young bird whose tail had measured $4\frac{1}{2}$ feet, but he broke it in getting about. The young birds usually moulted about a year after hatching. This must have been the first moult of the adult plumage, which begins to appear in the autumn after hatching. In reply to a request for further particulars about the moult, Mrs. Williams stated the birds do certainly cast their long tail-feathers. The bird that had some feathers $4\frac{1}{2}$ feet long was then (March 1902) nearly three years old, and she thought it was at the second moult that a feather of that length was measured.

There is evidence here that, when left to themselves, the long tail-feathers are moulted in the ordinary way, at any rate for two

successive seasons after the first year in which the birds are hatched.

It will be seen that the absence of the moult, or the occurrence of continuous growth, if true for the birds in Japan, is not true for those reared in this country; and thus we have reason to doubt that uninterrupted or continuous growth of the tail-feathers is a fixed congenital peculiarity in the breed.

Mr. John Sparks in May 1901 supplied me with the following information concerning the method of treatment applied to the birds in Japan:—"In order to ensure very great length of tail, the cocks ought to be kept on a perch as much as possible after they are six months old; and the tail-feathers should be pulled gently every morning, grasping the centre bone-like part firmly with the finger and thumb and pressing steadily downwards towards the tip, each feather being done several times. This softens the quill and causes it to lengthen. The birds do *not* moult the tail-feathers, but if one or more come out others immediately grow in their places.

"The Japs themselves, those who take great pride in their birds, always roll the long feathers up like a lady rolls up her hair, and tie them, whenever the birds are let off their perches to walk about, which is about twice a day for an hour at a time.

"I have often seen them thus treated in Japan, and those which Mrs. Williams and the Hon. W. Rothschild had from me were so treated on the voyage by the man in charge of them, and I sent them down to St. Austell in their regular perch-cages."

There is here a detail in the treatment of the feathers which, so far as I can discover, has never been mentioned in any published account of the matter; and my own experiments, which I now proceed to describe, so far as they have yet gone, tend to show that this mechanical treatment of the feathers is the whole secret of the mystery.

My own Experiments.

In May 1901, I received from Mr. John Sparks twelve eggs, laid by the fowls of this breed in the possession of Mrs. J. C. Williams. I afterwards ascertained that some of these were the produce of the pair originally imported from Japan, others were from the offspring of this pair, but all the eggs were of perfectly pure breed with no cross or admixture whatever. The eggs were incubated by an English hen of mixed breed, and on June 13th ten healthy chicks were hatched. Of the other two eggs, one contained a dead chick, the other was addled or not fertile. This shows that the eggs were remarkably fertile and of great vitality.

The chicks were small, the eggs being not much more than half the size of ordinary table-eggs. Their colour was fawn, with a broad dark brown stripe down the middle of the back, a narrower stripe on each side of this, and a thin stripe of the same colour running from the outer corner of the eye. They were very

pretty, very active, and very healthy, and throve well on ordinary food, consisting of oatmeal, chopped meat and vegetables, and mixed grain of various kinds. One of the chicks was accidentally killed when I turned the hen out of the nest, having got beneath its mother's feet as she was scratching the earth. I examined this specimen, and found that the primaries and secondaries of the wings were present as short black quills with a little down at the tip, but that there was no trace of tail-feathers or tail-coverts, nothing but down over the rest of the body. The comb was visible at the back of the beak as a slight yellow ridge with six teeth. The toes were four in number; the skin on the legs was yellow.

June 23*rd*. *Age* 10 *days*.—Another chick had been lost up to this date, having escaped and probably fallen a victim to a cat. The feathers of the wings now reached nearly to the end of the body, and were chequered in colour, being marked transversely with dark colour and grey alternately. The tail-feathers, *i. e.* rectrices, had begun to sprout in some of the chicks, elsewhere there was still only down. The combs appeared no larger.

July 6*th*. *Age* 23 *days*.—The chicks were now half-fledged: another had been lost by escaping, so that only seven survived. Feathers were growing on the shoulders and sides of the breast, but the head, back, and front of the breast were still downy, with the original markings. Tail-coverts also appearing. Feathers, except tails, all barred with dark and grey, so that the general appearance was speckled and very inconspicuous against the soil. The tail-feathers were dark, nearly black, but not steel blue-black like those of the adult. It was interesting to see the chicks scatter in all directions, and then crouch down whenever the hen uttered her special warning cry, as she did often when she heard a jackdaw croak. In four of the chicks the tails were more developed than in the rest; in these also the combs were beginning to grow higher and to get red. These four proved to be cocks, so that the sexual difference begins to show itself at this early age.

July 28*th*. *Age* 1 *month* 15 *days*.—The four cocks showed their sexual characters a little more distinctly, the wattles and ear-lobes being indicated by a tinge of red. In the three hens the combs had not begun to enlarge and showed no red.

One of the cocks was darker than all the other chicks, and had a slender tail, not very long and bent downwards. The hens were light-coloured, with white breasts, their tails being as long as those of some of the cocks. Two of the cocks had dark breasts.

Aug. 4*th*. *Age* 1 *month* 3 *weeks*.—Chicks now fully fledged. In the four cocks reddish tints were appearing in the feathers of the back and wings, while in the hens only neutral tints were present. The combs in the cocks were a little more developed, in the hens not developed. The tail-coverts in the cocks were growing, but not longer than the rectrices, and the sickle-feathers not conspicuous.

The red feathers mentioned above are the beginning of the

adult plumage. There is at least one complete change of feathers, from the chicken plumage to the adult, both in cocks and hens. Whether the chicken-feathers are changed before this I do not know, but there were indications that the wing-feathers at least, in the chicks, had been changed before the assumption of the adult plumage.

Aug. 12*th*. *Age* 2 *months*.—I examined one of the cocks, and could distinguish two steel-blue sickle-feathers on each side, not longer than the rectrices and rather narrow. These were the first of the adult tail-feathers to appear, succeeding others of dark, lustreless, brownish black.

Aug. 20*th*. *Age* 2 *months* 1 *week*.—I counted the tail-feathers in some of the chicks. In one of the hens I found 14, or 7 pairs, of rectrices. In one of the cocks, the dark one previously mentioned, the saddle-hackles were almost black with a grey stripe down the centre, instead of reddish. In this bird I found also seven pairs of rectrices, and only four pairs of sickle-feathers which were neutral brown. The other three cocks could also now be individually distinguished, and I give the peculiarities to show the amount of variation :—

A. The largest: more advanced in plumage than the rest, more red on the back, breast nearly all black except at the sides; a kink in the comb.
B. Similar to A, but not quite so far advanced.
C. Similar to A and B, but lighter in tone; back rather yellowish than red.
D. The dark bird above mentioned.

Aug. 24*th*. *Age* 2 *months* 11 *days*.—Examined Cock A and found a number of steel-blue sickle-feathers, or tail-coverts, all with very long horny sheaths at the base indicating vigorous growth. In Cock B similar feathers were only just beginning to sprout.

Aug. 26*th*.—In Cocks C and D very few new sickle-feathers showing. In B the rectrices were being replaced.

Sept. 6*th*. *Age* 2 *months* 3 *weeks*.—In Cock A all the chicken-rectrices had been moulted, and the new steel-blue ones were growing out with long horny sheaths at the bases. In all the cocks the spurs had begun to show as very slight blunt knobs. None of the cocks had crowed yet.

Sept. 10*th*.—Examined one of the hens. Saw several tail-coverts growing with long sheaths but no new rectrices.

In Cock D, the dark one, the two central rectrices were long, slender, and curved, and had sheaths at the base, also sheaths to some of the other rectrices. I thought at the time that these central rectrices had not replaced others in the chicken plumage, but grown continuously. I afterwards concluded that they had moulted earlier than in the other cocks.

In Cock A the longest tail-covert measured 19 cm. or about $7\frac{3}{4}$ inches.

Sept. 19*th*. *Age* 3 *months* 1 *week*.—Condition of plumage :—

Cock A. Breast, thighs, and belly all black. Neck-hackles very light grey, with thin dark stripe down the centre of each feather. Back with some steel-blue feathers behind the hackles, the rest red. Saddle-hackles developing, yellow, long and thin. Nearly all the rectrices and tail-coverts growing with long sheaths, colour steel-blue.

Cock B. Nearly the same as A, but not quite so far advanced.

Cock C. Much less advanced, white on sides of breast, speckled brown feathers mixed with red of back, only the outermost rectrices showing sheaths.

Cock D. Very little white on breast, hackles of neck steel-blue, back black with a little red at tips of feathers. Saddle whitish. Rectrices 7 pairs, only the central and outermost pairs with sheaths, the rest apparently not yet moulted.

Hens. Breasts almost white, the sides of breast buff; neck-hackles dark, with whitish stripes down centres of feathers. Back and tail greyish brown, speckled, *i. e.* with white quills. Two hens with black heads, one with head lighter, grey and speckled.

I now decided to stroke and pull the tail-feathers in Cock B and to leave Cock A untouched, to see if any difference would result. These two, as I have said, were closely similar except that A was the larger, finer bird and slightly more advanced in development. I chose, therefore, the one which was congenitally inferior, so that if any superiority in growth of feather appeared in it, it could only be due to the artificial treatment. In both there were seven pairs of rectrices, the central pair slender and curved, the rest broad and straight. The outermost pair had not yet been moulted. I fixed up a sort of cage with a round perch at the bottom, and put Cock B into it while I stroked his feathers, but did not keep him in it.

Oct. 1*st*.—Found that the hens had shed most of their rectrices and were producing new feathers, as well as new tail-coverts, but without change of colour.

Oct. 7*th*.—The upper tail-covert in Cock A measured 25 cm. or about 10 inches, not including the basal sheath.

At this time I changed my residence, and the fowls were installed in a place divided into two runs; into one I put Cocks B, C, and D, in the other Cock A with the three hens.

On Oct. 12th Cock A crowed for the first time, another proof that he was a little more precocious than the others.

Oct. 16*th*. *Age* 4 *months* 3 *days*.—Longest feather, a tail-covert on left side, in Cock B 27 cm., about the same as the longest in Cock A.

Oct. 27*th*. *Age* 4 *months* 2 *weeks*.—Tried tying the cocks by one leg on ordinary perches about 3 feet from the ground, and thus was able to measure the feathers better.

Cock A. Longest feather 13 inches from skin.

Cock B. The same. But there were *more* long feathers in Cock A, the outer ones being more nearly the length of the middle.

As I found I had not time to pay attention to more than two cocks, and as, moreover, they soon began to fight, I got rid of Cocks C and D; and what I have to say hereafter refers only to Cocks A and B, which were undoubtedly the best of the four, and had the most beautiful colours. I began tying these two cocks on ordinary perches in the daytime by means of a piece of tape tied to one leg and round the perch.

Dec. 1*st.* *Age* 5 *months* 18 *days.*—Longest feather in Cock A 18 inches, in Cock B the same. This shows a growth of 5 inches in five weeks, or 1 inch per week. Perhaps the feather in Cock A was really a little longer, as nearly all the feathers in this bird had lost their tips by friction against the ground. There is thus no evidence up to this time that pulling the feathers in Cock B has increased the rate of growth.

Dec. 8*th.*—I had been stroking the feathers of Cock B regularly at morning and evening. Usually I tied the birds on the perches at night, and generally tied the feathers up in paper when the birds were free. I used tissue-paper, and rolled the tail up transversely, fastening it with tape. I tried a rough narrow cage with wooden bars for Cock B, but the bird turned round and escaped through the opening behind the perch.

I noticed now that one of the long feathers in Cock B seemed to have stopped growing, the sheath having peeled off and left a dry stalk. This was one of the outer tail-coverts, but the rest were still growing vigorously.

Dec. 27*th.*—As my first attempt at a cage did not succeed, and I was unwilling to confine the birds so completely as the Japanese do, I made a perch of about 9 inches in length supported on two uprights. This apparatus was movable, not fixed to the ground. I used this for Cock B, tying him to it by a piece of tape fastened round one leg. This answered very well, although he once upset the perch and slightly wounded his head. No permanent injury resulted from this accident.

On this date, when I was stroking the feathers, one of the smaller tail-coverts on the right side came out of the socket, with the epidermic sheath attached to it. This feather was 14 inches long. This seemed to indicate that the effect of stroking the feathers was, as suggested by a correspondent of 'Nature,' to pull the growing feathers out, instead of increasing their growth; but my experiments were not finished yet.

Dec. 31*st.* *Age* 6 *months* 18 *days.*—Measured the feathers as accurately as possible on a flat wooden measure.

Cock A longest two feathers, the central feathers of the tail, 22 inches.

Cock B longest feather scarcely 22 inches, also a central rectrix.

It seemed, therefore, that the growth of the feathers in Cock B was barely keeping pace with that in Cock A, although only in the former were the feathers pulled or stroked. In Cock A the longest feathers were the two central rectrices; in B only one of the central rectrices was as long, the adult feathers having mostly started earlier in A than in B.

Up to this time Cock A had been with the three hens, and B with the other cocks until I had got rid of these.

1902, *Jan. 8th.*—On this date one of the hens laid the first egg. It was small and of light brown colour, like those the birds were hatched from.

The hens have a low serrated comb and scarcely any wattles, only red skin about the cheeks.

Jan. 12th. Age 7 months.—In Cock A the 2nd pair of rectrices, counting from the middle, seemed to be coming to the end of their growth, the sheaths drying up and the quills forming. This pair were not so long as the corresponding pair in Cock B which had been pulled. The five outer pairs of rectrices had ceased growing in both cocks. These were broad and stiff and only about 6 or 7 inches long, in fact like the rectrices of ordinary fowls. All the hens were now laying. One of the hens was put with Cock B, the other two with A.

Feb. 4th. Age 7 months 22 days.—

Cock A, longest feather.....	$25\frac{1}{2}$ in.	= 64 cm.
Cock B „ „	$25\frac{7}{8}$ in.	= 65·7 cm.

It is thus evident that the growth in B had been greater than in A. The feathers in B were pulled once or twice a day whenever I was at home, and B was tied on the perch with his feathers loose at night, while A was usually left free with his tail rolled up in paper. The sheaths of the central rectrices, which were the longest feathers in both birds, were in Cock A shorter, and seemed as though growth were about to cease.

It is to be noted here that so long as the feather is in full growth, the horny sheath which surrounds the base is milky white, or bluish white, and soft, while when growth ceases the sheath dries up and appears black because the feather is seen through it; then it scales off, and leaves the quill of the feather bare down to the surface of the skin. The quill at the base of a full-grown feather is only formed at the end of growth, and most of it is contained in the skin-socket. Thus I learned to recognise the approaching cessation of growth and formation of the quill by the appearance of the horny sheath.

Feb. 10th.—One of the feathers was accidentally pulled out in Cock A while the tail was tied up in paper. I do not know how this occurred; I only saw the root of the feather hanging free while the length of it was held by the paper. When a growing feather is thus pulled out, the horny sheath comes out of the dermal socket and remains attached to the base of the feather,

and the end of the sheath is quite soft and exudes a little blood and moisture when pressed. This feather was 52·8 cm. or about 1 ft. 9 in. long. It was one of the anterior tail-coverts, and was the only feather ever pulled out of Cock A.

Feb. 11*th*. *Age* 8 *months nearly*.—On this date, when I was stroking the feathers of Cock B, another came out. It was one of the anterior lateral coverts of the right side, and its length was $15\frac{1}{4}$ inches (38 cm.). The feather had not ceased growing, but showed signs that it was about to cease, as the rhachis at the base was stout and thick, and the barbs emerging from the sheath were free and downy, as they are at the base of a full-grown feather, and never at its more distal part

Feb. 14*th*.—Examined the bases of the feathers in both cocks. In A the central rectrices had nearly or quite ceased growing, and also nearly all the tail-coverts, only two or three still showing the basal sheaths. In B two or three of the posterior coverts had ceased growing on each side, but a number of the others still showed vigorous growth.

Feb. 15*th*.—The longest feather in Cock B came out when I was stroking the feathers, though I was not pulling at all hard. The feather was the central rectrix of the left side, and was in growing condition, with bluish pulpy sheath at the base. It came clear out of the socket and was not broken off at all. The extreme length was 2 ft. $4\frac{1}{4}$ in., but about 1 inch of this was in the socket before it was pulled out. The total length of the sheath up to the point where the feather proper emerged was $3\frac{1}{5}$ inches (8 cm.).

Feb. 16*th*.—Ascertained that in Cock B three tail-coverts on the right side had ceased growing and two on the left. The 2nd rectrix on right side had ceased to grow, that on the left nearly so.

In Cock A the 2nd pair of rectrices had ceased growing, the 1st or central pair had nearly ceased. Two central coverts, which were nearly as long as the central rectrices, had nearly ceased, and there were only two others on each side with growth-sheaths.

There were two rows of coverts in front of the rectrices, anterior and posterior, with four or five feathers in each row on each side. When the feathers are specified individually they are counted from the middle line.

Feb. 17*th*.—One of the posterior lateral coverts on right side in Cock B was pulled out today. I was really trying to see if it would come out when pulled, as it had completely ceased to grow. I found that it required much more force to pull it out than is required in the case of a growing feather. The quill was completely formed. It was evident that the attachment of the feathers was most feeble when growth was ceasing, not when the feather was growing vigorously; while after the quill was completely formed, the feather was very firmly held in the socket. The feather was $19\frac{1}{2}$ inches long.

March 2*nd*.—In Cock B another feather was unintentionally pulled out. It was in full growth, and was one of the lateral anterior coverts on the right side. Total length $16\frac{1}{2}$ inches.

March 4th.—Measured feathers, exactly four weeks since last measurement:—

Cock A, longest feather..... 2 ft. $3\frac{1}{2}$ in.
Cock B „ „ ..... 2 „ $4\frac{1}{2}$ „

The longest feathers in A were the two central rectrices, and these had almost entirely ceased growing since last measurement. They had grown $2\frac{3}{8}$ inches in four weeks.

In B, on the other hand, the longest feather was the central rectrix on the right side, which was still growing and was 1 inch longer than the rectrices of A. The left rectrix of B, which was pulled out, would have been somewhat longer.

In Cock A there were now only two feathers with growing sheaths, both on the right side, all the rest having ceased to grow. In Cock B, on the other hand, there were several coverts with growing sheaths, as well as the central rectrix of the right side.

March 9th.—The two feathers still growing in Cock A were the central posterior covert on the right side and one next to this on the same side. They seemed to be about to stop growing. There were only five long feathers in Cock A, all the rest being shorter than the corresponding feathers in B.

March 10th.—Another feather came out from Cock B today when the feathers were stroked; it was the 1st anterior covert on the left side, and, although still growing, showed signs of cessation of growth. It was evident that the feathers, as noted above, were easily pulled out at this stage. Feather measured 1 ft. $9\frac{3}{4}$ in. (55·3 cm.).

March 11th.—Still another feather pulled out of Cock B, 1st anterior covert of right side. It measured 1 ft. 8 in.

March 16th. Age 9 months.—The two feathers which were still growing in Cock A seemed now to have both ceased to grow, one of them certainly. The only other growing feather in this bird was the one on the left side which had sprouted in place of the one pulled out.

In Cock B four of the old feathers were still growing, namely, the right central rectrix, and three coverts on the left side, *besides the new feathers sprouting in place of those pulled out.*

Many of the golden saddle-hackles in B had growing sheaths. One came out when they were being stroked the other day, and measured 7 inches in length. A few of the feathers of the same kind were growing in A, but most have stopped, and these hackles altogether were about 2 inches shorter in A than in B.

Between the saddle-hackles and the long tail-coverts there were a number of feathers which may be called transition feathers. They were flexible and projected upwards first and then drooped in an arch; the outer ends were steel-blue, the bases carried pure white down, which was exposed and was very ornamental to the bird.

April 1st.—Measured the feathers, exactly four weeks since last measurement:—

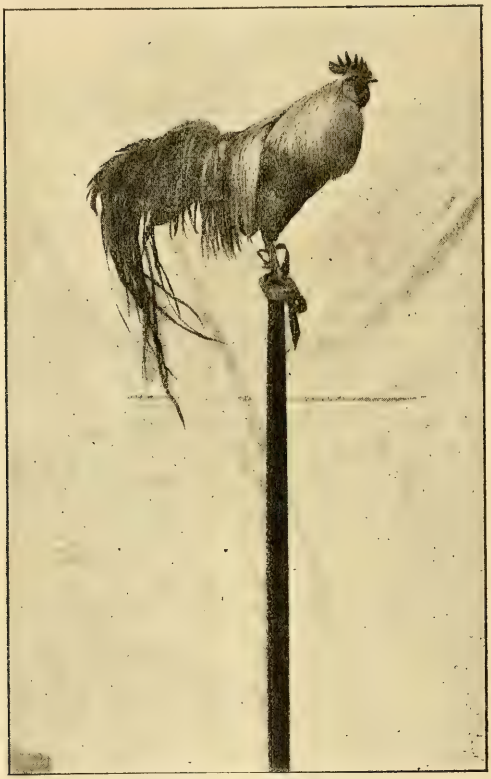
Longest feathers in A, central rectrices, 2 ft. $4\frac{1}{2}$ in.
Longest feather in B, right central rectrix, 2 ft. 8 in.

The rectrices in A had therefore grown 1 inch in four weeks, the rectrix in B $3\frac{1}{2}$ inches. The former had ceased to grow some time before this date.

One covert on the right side in A had still a little of the blue sheath at the base; it had almost finished growing, and was still shorter than the four longest central feathers.

In B the next longest feather was the central covert of the left

Text-fig. 41.



Japanese Long-tailed Fowl.
Cock A, photographed April 1903.

side, which was 1 ft. 11 in. long, or 9 inches shorter than the central rectrix. The left central rectrix, which had been pulled out on Feb. 15th, was growing again rapidly and was now about 4 inches long.

In Cock B the left central covert was still growing vigorously, with long sheath. It had a twist in it and hung in a spiral. Of the other two growing coverts on the left side, the outer had nearly ceased growing, the other still had a blue sheath.

I found that the feathers which had ceased growing for some time were very firmly attached. It was impossible to pull them out by moderate force, and I did not wish to pull them out by violence. There were 8 long coverts on each side in both cocks.

April 7th.—There were signs that more of the feathers in Cock B were coming to an end of their growth. The sheath of the right central rectrix was diminishing. The outer of the two upper

Text-fig. 42.

Japanese Long-tailed Fowl.
Cock B, photographed April 1903.

posterior coverts on the left side had, I believe, ceased to grow, and the inner, though still growing, was apparently about to cease. The only feather which appeared to be in full growth was the central covert on the left side.

April 13th. Age 10 months.—The right central rectrix in Cock B came out today when I was pulling the feathers. I had pulled it rather hard and rather frequently in the hope of stimu-

lating its growth, with this result. I am sure it would not have grown much more, as its growth was evidently ceasing.

Total length of the feather 2 ft. $9\frac{7}{8}$ in., of which $\frac{7}{8}$ in. was embedded in the socket.

April 20th.—On this date the light-coloured hen being broody, I put 9 of her own eggs under her to be incubated.

April 29th.—Longest feather in Cock B now was the central covert of the left side, which was 2 ft. 2 in. long and still growing. The covert next to this was also growing. The feathers which had been pulled out were all regrowing vigorously, the longest being the left central rectrix, which was 7 or 8 inches long.

In Cock A there was no further growth, except in the anterior covert which had been pulled out.

May 12th.—All of the eggs incubated by the light-coloured hen were hatched on this date, and all the chicks were vigorous and healthy. My experience of the breed has been in direct opposition to the statements in Lewis Wright's account, with regard to their vigour and fertility: I have found them exceptionally hardy, vigorous, and fertile.

There was no new variation observable in the chicks, except in one which was a rich golden-brown on the head and shoulders, instead of light buff colour. All were striped as described in the original chicks of the preceding season.

May 27th. Age 11 months 14 days.—Left central covert in Cock B 2 ft. 5 in. long, so that it had only grown 3 inches in four weeks. The covert next to this came out on this date when I stroked it. It was 2 ft. $2\frac{1}{2}$ in. long. It had evidently nearly ceased to grow, and was beginning to form downy barbs at the base.

June 2nd.—First signs of moulting noted in the hens; a good many of the breast- and body-feathers on the ground from day to day, and one primary wing-feather from the light-coloured hen found. There was, however, no sign of moulting in the tail-feathers of either cocks or hens. Cock A had lately been left at liberty with tail free, and none of the feathers had been broken or lost.

June 8th.—Hens moulting a good deal, more primaries shed, and in some cases the new primary was half developed. The primaries in each hen were shed a single pair at a time.

In the cocks none of the wing-feathers, saddle-hackles, or tail-feathers had been shed.

The chick of this season's brood which was browner than the others in the down, showed the same peculiarity in the immature plumage, having a yellowish-brown colour instead of the neutral brown of the others; the marking was the same.

June 24th. Age 1 year 11 days.—Left central covert in Cock B 2 ft. 8 in. long, so that it had grown only 3 inches in four weeks.

July 13th.—The left central covert in Cock B was accidentally pulled out when I was away from home; the paper in which the

feathers were tied up having come undone, the feather got caught in a door and was pulled out. There was some indication that the feather was ceasing its growth, as, although the sheath was long and soft, the barbs at the base were beginning to be slightly downy.

The total length of the feather was 2 ft. $10\frac{1}{4}$ in., or 2 ft. $9\frac{1}{2}$ in. beyond the socket.

As this completes the history of the feathers of the first season, I will here give a table showing the history of the feathers which were pulled out, as it is the further history of these feathers which constitutes the most important result of my experiment.

Feathers of first adult plumage in Cock B pulled out.

Right side of Tail.	Date of Extraction.
Small lateral covert, growing	Dec. 27.
Anterior lateral covert, nearly ceased	Feb. 11.
Posterior covert, ceased	Feb. 17.
Anterior lateral covert, growing	Mar. 2.
Anterior 1st covert, growing	Mar. 11.
Central rectrix, growing	Apr. 13
Left side of Tail.	
Central rectrix, growing	Feb. 15.
Anterior central covert, growing	Mar. 10.
Anterior 2nd covert, nearly ceased	May 27.
Posterior central covert, growing	July 13.

Of these it is important to note that all but the last two sprouted again almost immediately, and continued to grow, though not very fast, till the general moult. The last two did not appear again until the month of September, that is to say in the moulting-season. It is evident, therefore, that the recrescence of a feather is influenced by the season of the year. After the moult, that is to say in winter and spring, there is a general tendency to feather-growth, and if a feather is pulled out during this time a successor at once begins to grow in its place. After the end of April, at any rate in the second year of the bird's life, the activity of feather-growth slackens or ceases, and feathers pulled out after this time are not replaced till the following moulting-period.

July 31*st*. *Age* 1 *year* 1 *month* 18 *days*.—Found today that Cock A had begun to moult his wing-primaries: there were three or four new feathers growing, and one of them was already half its full length. Cock B was in the same condition, but had not shed so many feathers. The wing-secondaries were moulting also.

Aug. 4*th*.—Found one of the outermost short tail-coverts in Cock A growing again, the old feather having been moulted. This was the beginning of the moult in the tail-feathers.

I believe there were 10 tail-coverts on each side in each cock, but the two outermost on each side were small and unimportant. It will be seen from the list given above that only eight of the coverts in Cock B had been pulled out, so that eight feathers were left, apart from the rectrices, which had completed their growth, and could not grow any longer till they were moulted; while in Cock A all the feathers except one had completed their growth, and must necessarily have been moulted before they could have grown again.

Aug. 11*th.*—The longest feather in tail of Cock B now was the central rectrix of the left side, which I measured today and found to be 1 ft. $8\frac{1}{2}$ in. long.

The old feather was pulled out on Feb. 15, so that its successor had been growing nearly six months, and had grown at the rate of little more than 3 inches per month.

Aug. 16*th.*—One of the dark-headed hens had moulted all the rectrices as well as some of the tail-coverts, so that the rectrices were shed almost simultaneously.

Aug. 24*th.*—Found that Cock A had shed another short tail-covert, one of the transition-feathers, and also three of the outer rectrices: the latter were the 6th and 7th on right side and 6th on left, counting from the centre.

Cock B had shed none of the rectrices or old tail-coverts yet, but this morning when I was stroking the feathers the 1st anterior covert on the right side came out. The predecessor of this had been pulled out on March 11th, and it was in full growth. It was $13\frac{5}{8}$ inches in length, and this was the growth of five months. There was no reason to regard the loss of this feather as connected in any way with the moult, as growing feathers are not moulted.

The feathers growing in Cock B in place of those which were pulled out in the spring were as follows:—

Three anterior coverts on right side.
One posterior „ „
One anterior covert on left side.
Two central rectrices.

Sept. 1*st.*—The outermost rectrix on each side in Cock B came out when I was stroking the tail: they were loose and just about to moult. This may be regarded as the beginning of the moult of the tail, although one of the saddle-hackles and of the intermediate feathers had been moulted occasionally for some time.

Sept. 2*nd.*—The 2nd posterior covert on right side in Cock B, a full-grown feather, was moulted. It was 1 ft. $7\frac{3}{4}$ in. without the imbedded quill, 1 ft. $8\frac{3}{8}$ in. in extreme length.

Sept. 3*rd.*—6th rectrix on right side shed in Cock B; it was $7\frac{1}{2}$ inches long without the quill.

Sept. 4*th.*—1st (nearest centre) posterior covert in Cock B moulted; it was 1 ft. $7\frac{3}{8}$ in. long. Also one of the outer anterior coverts in Cock A moulted.

Sept. 5*th.*—In Cock B three rectrices and one covert on left side

came out when I stroked the feathers: these were all feathers of completed growth, which came out in consequence of the moult.

In the light-coloured hen, nearly all the rectrices and some of the coverts came out when I tried them. The two central rectrices in the hen were longer than the others, slightly curved downwards at the tip, and speckled with brown at the borders: length 22·5 cm. (9 inches) without quill. The other rectrices were broader and black, length 19·5 cm. (8 inches) without quill: the quill was 1·8 cm. in length.

Sept. 6th.—More tail-feathers moulted from Cock B this morning. The 2nd anterior covert on left side pulled out on May 27th had just begun to appear, so that renewed growth was deferred till the moulting-season.

Sept. 7th.—Nearly all the rectrices and longer tail-coverts which had completed their growth had now been moulted in Cock B. I had pulled many of them out without violence when they were loose. By looking at the base of the feathers, I could see when they were loose, because the transparent hollow quill was pushed out and was visible beyond the socket.

In Cock A only four of the rectrices and none of the longer coverts have been moulted spontaneously.

The left central rectrix in Cock B, which was still growing, measured today 2 ft. 0¼ in., or had grown not quite 4 inches in four weeks.

Sept. 18th. Age 1 year 2 months.—Today, when taking up Cock A to examine him, I accidentally trod upon the growing feather the predecessor of which had been pulled out on Feb. 10th. It was one of the anterior coverts on the left side, possibly the first. The feather broke off at the top of the sheath, the latter remaining in the socket. It was nearly 18 inches long (44·5 cm.), and would probably continue to grow from the same base.

This cock had still six long feathers not moulted, namely: the central rectrices, the 2nd pair of rectrices, and two posterior coverts.

In Cock B the fourth anterior covert on the right side, the outer of the three growing again, was coming to an end of its growth, showing downy barbs at the base, and it would be curious to see if it were moulted.

This fact is worthy of particular notice, for it proves that a feather which replaces one pulled out before the moulting-season does not necessarily continue to grow through that season, and it raises the question whether feathers which are growing when the moulting-season begins, necessarily grow longer or for a longer time than those which are moulted in the natural way. This question is answered to some extent by the subsequent observations.

At the end of September I ceased to reside at Penzance and came to London, and having obtained permission through my friend Mr. F. E. Beddard, F.R.S., to deposit the fowls at the Society's Gardens, I took them there on Oct. 1st. They were

accommodated in two of the pheasants' aviaries. I brought them from Cornwall in hampers in a night train, with the tails tied up in papers, and none of the feathers were injured. While they were at the Gardens I kept the tail of B tied up, while that of A, in which there were no long growing-feathers, was left free. Both the birds were left at liberty. During the fortnight after their arrival, all the remaining old feathers in both tails were shed, and the moult was thus completed, while in B there were left the seven long feathers which had grown in place of those pulled out earlier in the year.

This observation disposes, at any rate for these specimens, of the supposition that the tail-feathers of the breed are not moulted when left to themselves.

Oct. 11*th*.—Took away Cock B and the light-coloured hen from the Gardens and placed them in a private fowl-house. The left central rectrix measured 2 ft. $5\frac{1}{8}$ in., showing a growth of about 5 inches in five weeks. I fixed up a short perch on a stand, and at first allowed both birds to fly up to it in the afternoon, then later in the evening tied the cock to the perch and unfastened its tail till the morning.

Oct. 22*nd*.—I intentionally pulled out the fourth of the anterior coverts on the right side which had stopped growing, in order to make the new feather grow again. Thus there were left only six long feathers, all growing.

Oct. 29*th*.—In the morning found the Cock B hanging from the perch by the leg which was attached by the piece of tape. Generally, if he tried to fly off when he was tied, he was able to get back again, but this time the tape slipped down the vertical support, and he was unable to do so. In his struggles he had injured the longest feather, the left central rectrix, at the base, and it broke off near the top of the sheath. The detached part was 2 ft. $5\frac{1}{4}$ in. long. The root of the feather was uninjured, and the basal part continued to grow.

Nov. 2*nd*.—Measured the central rectrix of the right side, which was now the longest feather: it was 1 ft. 11 in. in length.

Nov. 15*th*.—Examined Cock A at the Zoological Gardens. The rectrices were nearly full-grown, except the two central pairs which were shed last, and which were only a few inches in length. The coverts were only a few inches in length, and were not likely to reach the ground for some weeks.

Nov. 17*th*.—This evening when I removed the paper from Cock B, I found that another of the long feathers had come out. The bird had been free all day, and must have pulled out the feather by catching it in some projection when wallowing in the earth, or must have accidentally pulled it out when preening himself. It was the second anterior covert of the right side, and was 1 ft. $9\frac{1}{8}$ in. long (53·8 cm.).

There were now only four long growing-feathers besides the left central rectrix which was not lost but broken off.

Dec. 6*th*.—I brought away Cock A and the other three hens

from the Gardens. The new feathers in A had grown no faster than the new feathers in B, in fact they were not quite so long. The longest feather in B hung about 2 ft. 3 in. from the perch, and all four of the long feathers were still growing. In Cock A, none of the feathers touched the ground yet.

Dec. 9th.—Another of the feathers in Cock B pulled out today, namely, the central anterior covert on the left side. The loss was due to accident when the bird was free, not to manipulation.

Since this date I had kept Cock B tied up nearly every day in a separate house, to prevent any more accidents. The feathers that were pulled out were all sprouting again, and there were three long feathers still growing, namely, the right central rectrix, one of the posterior coverts on the right side, and the third anterior covert on the same side. The first two were about the same length, that is about 2 ft. 6 in.

In Cock A, the 3rd pair of rectrices had ceased to grow, and were a little longer than the outer rectrices. The 2nd pair of rectrices were still growing, and were not much longer than the 3rd pair. The central pair were growing, and were only about 4 inches long. The tail-coverts were growing, but still very short.

In Cock B, the 2nd pair of rectrices were growing, and about 9 inches long; the 3rd rectrix on the right side had ceased to grow, and the basal sheath was peeling off, the corresponding feather on the left side was still growing.

Dec. 21st.—The third anterior covert on right side, which was pulled out last spring and grew again, appeared to have almost come to the end of its growth: the basal barbs were downy, and the sheath at the base had almost all peeled off. I had not pulled it out.

History of Feathers of Second Growth in Cock B, to Dec. 28, 1902.

Right side of Tail.

1st Anterior Covert: the preceding feather was accidentally pulled out while growing on March 11th, when it was 1 ft. 8 in. long. It was accidentally pulled out a second time while growing on August 24th, when it was 1 ft. $1\frac{5}{8}$ in. long. A successor immediately sprouted in its place.

4th Anterior Covert: stopped growing, and formed a complete quill a little before October 22nd, on which date it was purposely pulled out, and its successor sprouted in its place: it was not measured. Originally pulled out December 27th, 1901, when it was 1 ft. 2 in. long.

2nd Anterior Covert: preceding feather pulled out March 2nd when 1 ft. $4\frac{1}{2}$ in. long: accidentally pulled out again while growing on November 17th (1 ft. $9\frac{1}{8}$ in. long), and its successor sprouted in its place.

3rd Anterior Covert: predecessor pulled out February 11th, when

1 ft. $2\frac{3}{5}$ in. long: had almost entirely ceased to grow, but had not been pulled out: it was a little over 2 feet long.

Posterior Covert pulled out February 17th, 1902, when it was about 2 feet long. Now still growing, and about 2 ft. 6 in. long.

Central Rectrix: predecessor pulled out while growing on April 13th, when 2 ft. 9 in. long: was still in full growth, and about 2 ft. 6 in. long.

Left side of Tail.

Central Rectrix: predecessor pulled out while growing on February 15th, when 2 ft. $4\frac{1}{4}$ in. long: was accidentally broken off on October 29th, but continued to grow from the base, and the basal portion is now about 7 inches long. The total length of the feather, if it had not been broken, would have been 3 ft. $0\frac{1}{4}$ in.

1st Anterior Covert: predecessor pulled out growing on March 10th, when 1 ft. $9\frac{3}{4}$ in. long: accidentally pulled out growing on December 9th, when 2 feet long. Its successor immediately sprouted again, and was just showing.

There were thus in Cock B only three feathers left of the eight which had begun to grow before the moulting-season. The two longest of these were about 2 ft. 6 in. long, while the third was shorter and had ceased growing.

The other feathers which began to grow after the moult were on the whole longer than the feathers in Cock A; and the difference between the tails in the two birds, the one artificially treated and the other left to nature, was sufficiently striking.

Summary and Conclusions.

These observations extended only to the 2nd moult, or the first shedding of the adult plumage.

They show that when the feathers are not pulled or artificially treated in any way, care being taken to protect them and prevent them from being accidentally pulled out, the growth continues till about the end of March, when it ceases, the quills of the feathers are formed in the normal way and the feathers are moulted normally in the following autumn.

On the other hand, when the feathers are pulled out in the spring, successors immediately sprout in their places, continue to grow till the following season, when they go on growing without moulting, except in some cases when growth may come to an end in the moulting-season.

In the cock whose feathers were stimulated by pulling, growth did not go on at a more rapid rate, but continued for a longer time and produced a longer feather. Thus in Cock A, no growth took place after April 1st, and the maximum length was 2 ft. $4\frac{1}{2}$ in.; while in Cock B, growth continued till July 13th, and the maximum length was 2 ft. $9\frac{1}{2}$ in.

I think it is tolerably certain that these experiments explain the method adopted by the Japanese in the production of tail-feathers of extreme length, and that much that has hitherto been mysterious and inexplicable in the matter is now explained. The statement that the feathers do not moult or moult only once in three years, or that the Japanese have a secret method of preventing the moult, is explained if we assume that the Japanese fancier strokes the feather as Mr. Sparks stated, and that he either deliberately pulls a feather out when it shows signs of diminishing growth, or that the feather is automatically pulled out in the process when its growth diminishes; because, as I have shown, the attachment of the feather is very feeble when the growth is ceasing. As a rule, when a feather is pulled out its successor immediately sprouts again, and its growth is afterwards continued regardless of the moulting-season. The results of my experiments in fact are in complete agreement with the statement of the matter furnished by Mr. Sparks.

The long-tailed cock in its perfection, therefore, is neither a sport nor a breed, but a product of artificial cultivation; and the excessive growth of the feathers is the result of stimulation applied to the individual. The most important part of the stimulation is not the mere pulling of the feather, but the extraction of it which causes the growth of its successor.

On the other hand, the method of treatment is applied not to any breed at random, but to a particular breed which includes several varieties of colour, and apparently two varieties of comb. It can scarcely be supposed that the same treatment applied to another breed would produce results at all comparable, and we therefore may conclude that in this special breed there is a special and extraordinary tendency to growth in the tail-feathers and saddle-hackles. The congenital peculiarity is evidenced in the case of Cock A in my experiment. The question therefore arises, whether this congenital peculiarity has been developed entirely by spontaneous variations and selection, or whether it has been influenced by the excessive growth artificially induced in every generation. It is probable enough that in most cases a cock which showed the most rapid and most prolonged growth was used for breeding, but it is by no means certain that the cocks so used were never subjected to the artificial treatment. The probabilities are rather the other way, that specimens which had been found to respond to the treatment were used for breeding. It is a significant fact that this is the only breed of long-tailed fowls in existence, and that the method of treatment applied to it is so elaborate and so absolutely artificial, requiring daily attention for months and years. If a similar result could have been obtained by selection alone, it is difficult to understand why poultry fanciers in some part of the world have not made the discovery.

The results of this investigation are remarkably in agreement with the theory advocated in my book 'Sexual Dimorphism in the Animal Kingdom.' In that book I pointed out that wherever

hypertrophy of organs or parts occurred in one sex only, the parts affected were subjected by the habits of the animal, as known by observation, to special irritation and stimulation.

Postscript, added April 25th.—On March 9th, as the left central rectrix in Cock B seemed to be ceasing to grow, I tried to pull it out, but it broke off at the top of the sheath. The total length from the surface of the skin was 4 feet. The right central rectrix in the same bird on March 16th was 3 ft. 4 in. long and still growing. At present it shows no sign of cessation of growth, and has now been growing for more than a year. The appearance of the two birds at the present date is shown in the two photographs (text-figs. 41, 42, pp. 240, 241).

2. On some Nudibranchs from East Africa and Zanzibar. Part II.[1] By Sir C. Eliot, K.C.M.G., H.M. Commissioner for the East Africa Protectorate, F.Z.S.

[Received February 20, 1903.]

Ceratophyllidia africana, gen. et sp. nov.

One specimen from near Wasin, E. Africa, in 9 fathoms.

The living animal was described by Mr. Crossland, who dredged it, as of a light greenish-yellow colour on the upper surface, but with the foot, branchiæ, and under side of mantle, white. The back was very hard and smooth, but its most remarkable characteristic was the presence of a number of papillæ, consisting of round or pear-shaped bodies set on stalks. The stalks as well as the base and tip of these globes were white, but the middle part was black, owing to a dense aggregation of black spots, which, however, can be seen to be separate under a lens. The globes were quite soft and the stalks flexible; they shook when the animal was moved, but were not observed to execute any spontaneous movements. The mantle-edge was wavy.

The alcoholic specimen is of a uniform pale lemon-yellow, the black bands of the globes being, however, preserved. The breadth across the middle of the back is 1·9 centim. Unfortunately the animal is contracted almost into a circle, but apparently the length, when stretched out, must have been about 2·2 centim. The consistency of the body is like hard wax, and fragments of the mantle, which is ample, could easily be detached with the forceps. The whole dorsal surface is a mass of closely packed spicules. It bears about a hundred of the stalked globes. They are of very varying size; many are quite minute, but the largest is about 3 millim. high including the stalk, and about 2 millim. across the ball, which is quite soft and can easily be pressed flat. They are distributed over the whole of the back irregularly, and not in any pattern, but are perhaps thickest round the mantle-edge, including the space in front of the rhinophores. Both the

[1] For Part I. see P. Z. S. 1902, vol. ii. p. 62.

rhinophore-pockets and the anal papilla project; the edges are smooth. In the preserved specimen the rhinophores are grey.

The branchiæ are arranged in a circuit interrupted only by the head and genital papilla. They vary in size, but though in places long and short branchiæ seem to alternate, this cannot be said to be the general rule.

Over the mouth are two tentacles each about 1·5 millim. long, and 1 millim. broad at the base. They are not directed sideways but straight forward, and being set close together so that the division is not visible, they appear to form a sort of head. They are united at their bases. The mouth is larger than is usual in this order, and though it is suctorial is hardly poriform. Though the animal was dissected only three months after capture, the internal organs were already much dried and shrivelled, the spirit having apparently been unable to penetrate the hard integument. It was clear, however, that the buccal organs are of the type of *Phyllidiopsis* rather than *Phyllidia*. The buccal opening led into a sausage-shaped tube about 6 millim. long and 2 millim. broad, with muscular walls transversely striped. This passed into a long, narrow, coiled tube, which preserved the same calibre until it dilated into the stomach. Two ample glands (salivary?) entered the larger part of the tube on either side, but were not in any way fused with it. The liver was large and undivided behind.

The central nervous system was enclosed in a thin capsule and somewhat concentrated, the cerebral and pleural ganglia being hardly distinguishable and the pedal ganglia lying beneath them. The eyes were large, black, and distinct. The genital mass was much hardened, but the two spermatothecæ, one white and empty and the other black and full, were quite distinct. It was impossible to ascertain whether the glans was armed with hooks and whether the folds on the dorsal wall of the pericardium (sometimes called the pericardial gill) were present, but it is highly probable that the species possesses these family characteristics.

In virtue of its buccal apparatus this animal belongs to Bergh's genus *Phyllidiopsis*, although the tentacles are not attached through their whole length and are rather larger than is usual in the Phyllidiadæ. It is remarkable that the genus *Phyllidiopsis* contains one species, *Ph. papilligera*, which has also black papillæ on the back. To me, the presence of these dorsal papillæ seems a peculiarity sufficiently marked to merit generic rank. If *Echinodoris* is a genus, why should not Phyllidiadæ which have the same peculiarity enjoy the same distinction? I would propose to call the genus *Ceratophyllidia*, and its characters will be:—*Back studded with papillæ; buccal apparatus in the known species similar to that of* Phyllidiopsis.

Pleurophyllidiella horatii, gen. et sp. nov.

One specimen from Wasin, East Africa. Mr. Crossland, who captured it, gives the following notes on the living animal:—"Three inches long. Mantle edged with light salmon-colour; it

ends in two ridges near rhinophores, similarly edged; front edge of velum similarly edged. Back grey, mottled with a darker shade, the top of the numerous longitudinal ridges being sprinkled with clear black spots. Underside white. Gills also white. Rhinophores longitudinally lamellated, grey in colour, and can be contracted or retracted, though the pockets do not seem very definite or complete."

The somewhat bent alcoholic specimen measures 3 centim. from head to tail, but would be at least ·5 longer if it were straightened out. The breadth of the back is 1·5 centim., of the foot ·6. The foot is long and narrow, pointed behind and truncate in front, the corners not projecting.

No caruncle or nuchal papillæ are visible, but it is somewhat difficult to reconcile the head-parts of the preserved specimen with the description quoted above. According to a rough drawing made from the living animal, it would seem that the mantle-edge passes between the rhinophores and forms a sort of velum in front of them; but in the preserved specimen it appears to lie behind them as in an ordinary *Pleurophyllidia*, and not to pass through them at all.

The salient character of the genus is that there are no branchiæ and no trace of a branchial cleft. Lateral lamellæ are, however, present. They are situated exclusively on the under edge of the mantle, and not on the sides of the body. They extend from the head to the tail, and are about 30 in number on each side. They are irregular in size and shape. Some terminate before they reach the mantle-edge, and some run from the mantle-edge only halfway to the body. The genital papilla is 4 millim. and the vent 1·2 centim. from the anterior end of the body. Cnidophores are distinctly visible round the edge of the mantle.

The mouth is ventral, and forms a large transverse slit, with slight indications of a T-shape. The jaws are yellow, narrow, and united so as to form a shape like a boat. They bear no denticles, but there are a few irregular coarse indentations of the edge, due apparently to its being jagged by use. The radula consists of about 30 rows, the formula for each of which is about 50+1+50. The central tooth consists of a squarish basal plate with a long cusp, which bears about 10 denticles on each of its sides. The first lateral is larger than the others and resembles the central tooth, except that the denticles are only on the internal side. The second and third laterals are also denticulate; the rest appear to be simply hamate.

This form appears to be intermediate between *Pleuroleura*, which has neither branchial clefts nor side lamellæ, and *Pleurophyllidia*, which has both. I have indicated its affinities by the name *Pleurophyllidiella*.

Bæolidia major, n. sp.

(Bergh, in Semper's Reisen im Arch. Philipp., Malac. Untersuch. vol. iii. pp. 778–780, 1880.)

One specimen from Chuaka, E. coast of Zanzibar, under a stone between tides.

The living animal was about 4 centimetres long. The body and appendages were of a uniform greyish white, with spots of a dull opaque white. The whole animal closely resembled a kind of detachable sea-anemone which is very common at Chuaka, and appears to be sometimes almost free-swimming.

The alcoholic specimen is 3 centim. long and 1 centim. broad at the widest part, including the cerata. The foot is moderately broad, and has fairly long tentacular expansions in front; but its most remarkable character is the size and distinctness of the anterior groove, which measures 2 millim. across. The upper lip is separated into two parts by a deep cleft. The oral tentacles are large and very thick. The rhinophores are shorter and studded with minute knobs, which, in the preserved specimen at any rate, appear not to be set in rings. The cerata are much flattened and almost leaf-like, and the hepatic diverticula within them are ramified. They begin at the anterior end of the large pericardial prominence, and are arranged in about 17 groups on each side, each containing about 10 cerata. There are very distinct gaps between the anterior groups, and a broad bare space runs down the middle of the back, but towards the end of the body the cerata are huddled together and continue until the extreme tip, there being no tail. The outermost cerata of all the rows are smaller, and the inner considerably larger, but at the base of the innermost are frequently quite small, some hardly larger than tubercles. The genital orifice is below the first group of cerata, and the lateral vent behind the second.

The specimen was only partially dissected. The jaws are very large, colourless and transparent, with a perfectly smooth edge. The radula consists of 32 pectinate teeth, very similar to those of *B. mœbii* (see Bergh, *l. c.* pl. lxxix. fig. 16), with striations under each denticle. They are, however, very much broader, the widest measuring 2 millim., and the denticles are more irregular in shape, being probably worn by use. There are about 150 of them on the broader teeth. The three or four central denticles are generally, but not always, smaller than the others.

This specimen is clearly referable to Bergh's genus *Bæolidia*, and the difference between it and the type is mainly one of size, *B. mœbii* being only 8 millim. long. The similarity of habitat makes one think that this may be merely a full-grown individual of the same species; and we know so little of the variations which the radula and arrangement of cerata may present in Æolids at the different periods of their growth, that I am not prepared to reject this hypothesis. Still, the single specimen examined by Bergh appears to have been sexually mature, and this being so the two animals each present peculiarities amounting to specific differences:—(1) In *B. mœbii* the tentacles are said to be "äbgeplattet fingerförmig"; the cerata begin behind the rhinophores and are set in rows: in *B. major* the tentacles are stout and round;

the cerata begin further back and are set in groups. (2) In *B. mœbii* the reproductive orifice is under the third row of cerata, and the vent between the sixth and seventh rows, almost dorsal: in *B. major* the reproductive orifice is under the first group of cerata, and the lateral vent after the second. (3) In *B. major* the basal part of the teeth is proportionally narrower than in *B. mœbii*, and the denticles are more irregular.

Var. ORNATA.

One specimen captured at Chuaka, May 1902, seemed to be a typical *Bœolidia major*, except for a somewhat more ornate coloration. The ground-colour was of a yellowish-white with a yellowish-brown pattern, consisting of a series of irregularly shaped lozenges containing white spots, down the middle of the back as in *B. major*. The oral tentacles were white with green stripes. The cerata were white with yellow tips, below which was a bright blue band.

CERBERILLA AFRICANA, n. sp.

(Bergh, Journ. Mus. Godef. Heft ii. 1873, & Heft vi. 1874; Beitr. zur Kenntniss der Aeolidiaden, Theil ii.; Semper's Reisen im Arch. Philipp., Malac. Untersuch. iii. p. 879.)

One specimen from the reef Jembiani, Zanzibar, 3·5 centim. long and 1·3 broad in life. The back was almost entirely covered with cerata, so that the body-colour was hardly visible. Most of the cerata were very dark green with a bright yellow ring, but the innermost were white with bluish tips, with only a ring of dark green. The oral tentacles were dark blue, with green bases. The rhinophores had four bands of colour, which were, starting from the base, greenish brown, white, blue, white. On the head were two yellow lines, extending from the oral tentacles to the rhinophores, and the margins of the head and foot were also of a bright light yellow.

The animal was stoutly built. The foot projected considerably beyond the body on either side. Its anterior angles were expanded into long tentacular processes. The head had also two lateral expansions, from which projected at right angles the very large and conspicuous oral tentacles. In life the rhinophores were quite simple and fairly long. In the alcoholic specimen they were contracted and somewhat wrinkled. The numerous and thick-set cerata were disposed on peduncles. There was a bare triangular patch behind the rhinophore, and a narrow bare space down the middle of the back, but the cerata folded over the latter so that neither it nor the transverse bare areas were visible. There were about twenty transverse rows of cerata. The first row at the side of the rhinophores consisted of about 10 cerata, much smaller than the rest. After the third row was a distinct gap, and a smaller gap after the fourth. After that the rows were so close together that they could not be distinguished superficially. The innermost cerata were larger than the others, and sometimes bifid: small cerata extended almost to the end of the very short tail.

The jaws were large, with a smooth cutting-edge. The radula consisted of a single series of 13 transparent yellowish teeth of the shape usual in the genus, viz., pectiniform, with large irregular denticles and small accessory denticles. It was sometimes hard to decide whether the rather small denticles should be considered main or accessory; but the average number of main denticles on each tooth was 10, and the largest number (in one case only) 13. The central nervous system was somewhat concentrated. The specimen was only partly dissected.

A new species must, I think, be provisionally created for this animal, though the discovery of intermediate forms may perhaps render its retention unnecessary. In some ways it is itself a connecting-link between *C. longicirrha* and *C. annulata*, for the former is said to have 7, and the latter 5 denticles on each side of its teeth, whereas *C. africana* has 4, 5, 6, or 7 indifferently. It can hardly be *C. annulata*, for the difference in colour is too great, and besides there is much less bare space on the back. Neither can it be *C. longicirrha*, because (1) the coloration, though similar, is still distinct; (2) *C. longicirrha* has the back bare up to the 7th row of cerata, and some of the cerata are very long, which is not the case here; (3) the rhinophores are not perfoliate.

This last point is of some importance for the characterisation of the genus. In the present animal the rhinophores were undoubtedly quite simple in life, and in alcohol they are wrinkled, though it is still possible to see that they are not really perfoliate. In *C. longicirrha*, Bergh says the perfoliations are 14 or 15 in number, and not deep. Of *C. annulata* he says that the rhinophores have 12–14 well-marked perfoliations, and that Garrett has wrongly represented them as simple. But in Semper's 'Reisen,' xvii. he states that *C. annulata* var. *affinis* has simple rhinophores, and gives as a generic character: "Die Rhinophorien scheinen nicht perfoliirt zu sein." I have not access to part ix. of his 'Beiträge zur Kenntniss der Aeolidiaden,' which perhaps explains the matter; but it looks as if the rhinophores are simple, but have a tendency to simulate perfoliations when preserved.

Pteraeolidia semperi.

(Bergh, Beitr. zur Kennt. der Aeolidiaden, iii. p. 22, and in Semper's Reisen, Malac. Untersuch. vol. i. p. 18 (1870); under *Flabellina*.)

Four specimens, which seem probably referable to this species, were dredged from 3 fathoms near Chuaka in July 1901. The body is very long, narrow, and vermiform, the largest individual being 5·5 centim. long and only 3 millim. broad. The ground-colour of the body in the living animal is brown, with opaque markings of very light green on the sides and back. The cerata are also dark brown, with numerous thin lines of the same green. The top of the head and the ends of the oral tentacles are opaque yellowish white. The lower part of the tentacles brown, with three rings of

vivid crimson-lake. The body of the rhinophores is brown and inconspicuous, but the tips are whitish and have a crimson ring. Although the colour of the animal when analysed is as described, the general effect in most lights is that it is purple with a silvery glaze.

The specimens were active in their movements, and in particular the long oral tentacles were very mobile. The anterior margin of the foot was produced into two deeply-grooved processes, and its sides projected in two laminæ along the whole length of the body. The cerata, which were not at all caducous, were set on fan-like projections of the dorsal margin, from 13 to 20 in number, on each of which were from 10 to 20 cerata. The largest individual appeared to have about 640 cerata in all. None of the cerata were large, but they became more crowded and smaller towards the end of the body, where they extended to the tip of the tail. In three of the preserved specimens there was a very distinct raised border on each side of the back, connecting the fan-like projections, and almost resembling the mantle-edge of Dorids; but in the fourth this remarkable character was not visible. The oral tentacles were very large and long; the rhinophores, which stand between the first clumps of cerata, were small and lamellated, except the tips, which were narrow and smooth. In the individual dissected the radula consisted of a single series of 18 yellowish teeth. The separate teeth were much as represented in Bergh's plate (*l. c.* pl. iii. figs. 5, 6, 7), but somewhat more regular in shape, having nine denticles very symmetrically arranged on each side of a central cusp, but not taking the form of indentations of the cusp itself. The cutting-edge of the jaw bore a row of fine but very distinct denticles, at the side of which were several rows of less distinct accessory denticles. No spine or other armature was discovered in the reproductive system.

These specimens seem to clearly belong to Bergh's genus *Pteraeolidia*. There are some small differences (such as the shape of the rhinophores and of the teeth and the lateral ridges) between them and his description and plates of *Pteraeolidia (Flabellina) semperi*, but the ridges were absent in one specimen and the other characters were slight. It is possible, however, that a comparison of the living animals might show a specific difference.

Ercolania zanzibarica, n. sp.

(For the genus *Ercolania* see Trinchese, "Un nuovo genere della fam. degli *Eolididei*," Ann. del Mus. di Stor. Nat. di Genova, ii. 1872; id. "Aeolidæ del Porto di Genova"; Bergh, Beitr. z. Kennt. der Aeolidiaden, v. pp. 9–18, Wien, 1878; Vayssière, Recherches sur Moll. Opisthobranches, Marseilles, 1888, pp. 121–128.)

Two specimens captured at Chuaka, East Coast of Zanzibar, in February 1901. The living animal was rather more than 2 centimetres long, very fragile and delicate, transparent and of a uniform bright green, the hepatic diverticula in the cerata not

having been distinguished by any difference or intensity of colour. It exactly resembled a piece of the racemose seaweed (*Caulerpa*) on which it was found.

The length of the alcoholic specimens is 2 centim.; the extreme breadth of the back with cerata 8 millim., and of the foot 2·3 millim. The rhinophores are long and distinctly canaliculate. There are no oral tentacles, but two lobes over the mouth. Behind the rhinophores are two very distinct black eyes. The cerata are club-shaped as in *Galvina*, of varying size, the largest inside. On each side of the back are four clumps of about nine cerata each, and there is a thick bunch on the tail, which, however, projects a considerable distance behind the last cerata. Down the centre of the back is a broad bare space, in the anterior portion of which is the very large, elongated (not oval) pericardial prominence. In front of this and fused with it is the vent, a large and conspicuous tube. The foot is rounded in front.

I dissected one specimen, but was unable to obtain a clear view of either the central nervous system or the reproductive organs. The latter, as usual in this family, were extremely complicated, both the prostate and albumen-gland appearing to be extensively ramified. The verge was armed with a small spine. The hepatic diverticula in the cerata, being colourless, were not easy to distinguish, but appear not to be much ramified and to resemble the figure of those in *Ercolania siottii* in Trinchese, pl. ix. fig. 2.

The mouth-parts, buccal muscles, radula, &c. are of the usual ascoglossan type. The teeth are not unlike those of *Ercolania viridis* (v. Bergh, *l. c.* pl. xii. figs. 3 & 4), but the dorsal surface is a simple curve and does not show any depression. The upper portion of the radula contains 6 teeth, the lower 27, the last members being arranged in a spiral like that depicted in Trinchese's plate of *E. siottii* (pl. x A. fig. 1), from which it may be concluded that the individual is young.

As the specimen presents all the characters of the genus *Ercolania*, I describe it under that name, but I feel very doubtful if the genus is valid. The only characters which differentiate it from *Stiliger*, viz. that the rhinophores are canaliculate and the pericardial prominence elongate and not oval, are surely very slight. Vayssière (*l. c.* p. 122) referred to the genus a species (*funerea*) with entire rhinophores, which is probably in any case a *Stiliger*.

The animal is not likely to be specifically identical with *E. viridis* Bergh, for the coloration is not really the same, the size is much larger, and the shape of the teeth somewhat different.

3. Contributions to the Osteology of Birds. Part VI. *Cuculiformes*.[1] By W. P. Pycraft, F.Z.S., A.L.S.

[Received March 17, 1903.]

(Plate XXII.[2] & Text-figures 43–48.)

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i. Introductory Remarks.

Although numerous contributions to the osteology of the Cuculiformes have been made during the last quarter of a century, the present paper claims to be the most comprehensive survey of the group from this point of view which has yet been made. Nevertheless, much remains to be done before our knowledge is anything like complete on this subject. How much, may be gathered from the fact that out of 45 generally recognised genera of the Family Cuculidæ, only 20 are represented in the osteological collections of the British Museum, and this appears to be the largest collection of the group extant. Of the 6 genera of the Family Musophagidæ, only 2 are represented in our series.

ii. The Skull of the Adult.

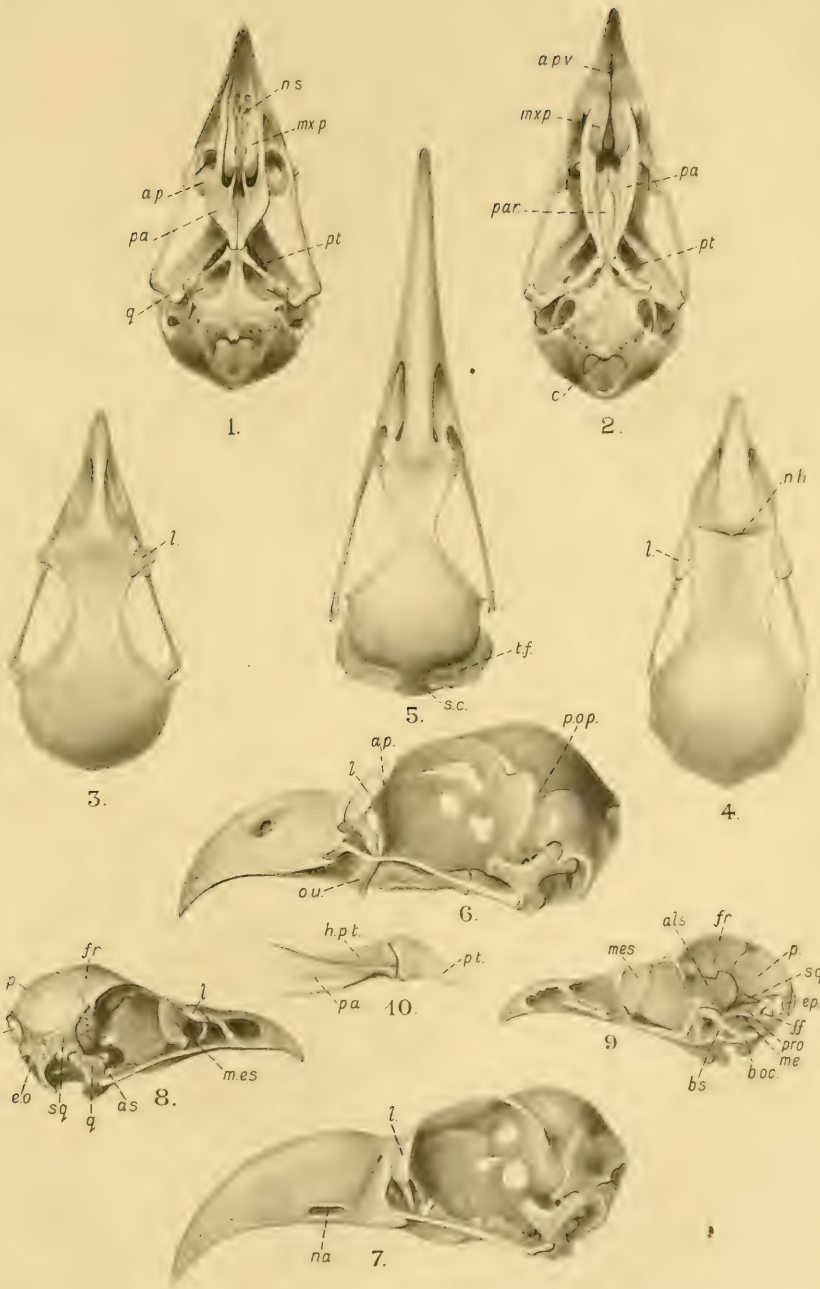
The skull of the Cuculiformes recalls, on the one hand—through the Cuculi—the skulls of certain Coraciiformes, e. g. *Coraciidæ* and *Buccones*; and on the other—through the Musophagi—the skull of the aberrant Galliform *Opisthocomus*.

Nevertheless the Cuculiform skull may at all times be readily distinguished, and by the following characters:—

The pterygoid is always free, and articulates with the palatine —after the fusion of the hemipterygoid—by a more or less obliquely transverse joint; the lachrymal is always present and free; the antorbital plate (prefrontal) is large, and generally (if not always) bears an os uncinatum; the vomer is vestigial or wanting; the palate is indirectly desmognathous; basipterygoid processes are wanting; and the postorbital processes are small and inconspicuous, never extending down to the level of the quadrato-jugal bar.

The skull of the Musophagi may always be readily distinguished from that of the Cuculi by the fact that the mesial borders of

[1] For Part V., see P. Z. S. 1902, vol. i. p. 277.
[2] For explanation of the Plate, see p. 291.



H. Grönvold. del. Photogravure by Bale & Danielsson

OSTEOLOGY OF THE CUCULIFORMES

the palatines are cut away so as to expose the parasphenoidal rostrum.

The Occipital Region.

The plane of the occipital foramen slopes obliquely backwards; the orifice is either reniform or cordiform. In the obliquity of this foramen the Cuculiform skull differs conspicuously from many Coraciiform skulls wherein the foramen looks directly downwards, its vertical axis lying parallel with the long axis of the skull. The *supra-foraminal ridge* is but ill-defined, but can be indistinctly traced running downwards, on either side, into the processus alæ occipitalis.

The *lambdoidal ridge* in the Cuculi is generally well-defined and bluntly conical in outline. In some genera, e. g. *Crotophaga*, *Centropus*, *Guira*, *Rhopodytes*, *Rhinococcyx*, and *Saurothera*, its extremities bifurcate, sending forward an anterior band across the inferior border of the squamosal to terminate in a pointed squamosal prominence overhanging the quadrate; and a posterior branch, which turns downwards and backwards to disappear on the free edge of the lateral occipital. Where the lambdoidal ridge is well-developed, the cranial roof, lying immediately in front, is more or less flattened, often, indeed, marked by deep temporal fossæ.

In many genera the lambdoidal ridge is much less distinct. This occurs where the cranial roof is strongly arched so as to rise above the ridge with a strong curve, and temporal fossæ are wanting or confined to the sides of the cranium, e. g. *Coua*, *Cacomantis*, *Chrysococcyx*.

The supraoccipital region is marked by strong muscular depressions, which in the case of *Coua*, for example, take the form of widely-separated oval scars, each surrounded by a swollen border; whilst in others, as in *Eudynamys*, these depressions are only divided in the middle line by a narrow ridge, and are bounded infero-laterally by slightly swollen bullæ produced by the lateral occipitals.

The lateral occipital wing is produced downwards on either side into a small or medium-sized *processus alæ exoccipitalis inferior* (paroccipital process).

In the Musophagi the lambdoidal ridge is fairly well-defined in *Schizorhis*, but only very imperfectly so in *Turacus*.

The ridge in *Schizorhis* is formed by the scooping-out, so to speak, of the supraoccipital to afford depressions for the insertion of the cervical muscles. On either side, and inferior to these depressions, are two rather conspicuous bullæ lodging the posterior and horizontal semicircular canals of the ear. The distal ends of the lambdoidal ridge terminate before reaching the free edge of the lateral occipital wing. The *processus alæ exoccipitalis inferior* is only feebly developed.

The lateral or exoccipital wings are not greatly developed in the Cuculiformes.

The Cranial Roof.—The cranial roof is never marked by supra-orbital grooves.

The parietal region, in certain genera of Cuculi, is marked by deep temporal depressions (temporal "fossæ"), which may meet in the middle line so as to form a faint sagittal crest, e. g. *Rhopodytes*, *Piaya*, *Rhinococcyx*, and *Rhamphococcyx*; or they may be divided by a low broad ridge, as in *Geococcyx*, *Taccocoua*, *Saurothera*, *Eudynamys*, *Guira*, *Centropus*, and *Crotophaga*. In *Coua*, *Coccystes*, *Cuculus*, and *Cacomantis* the temporal fossa is either barely perceptible or confined entirely to the lateral aspect of the cranium. *Geococcyx*, it should be remarked, presents an intermediate stage in this character; the width of the ridge dividing the right and left fossæ being extreme, so much so that they barely pass beyond the lateral aspect of the skull.

The interorbital region is moderately wide in all the Cuculi, save in *Saurothera*, but even in this genus it is not conspicuously narrow. In the middle line the region may be marked with a distinct furrow as in *Coua*, or even by a low ridge as in *Eudynamys*. The interorbital region is bounded anteriorly by the lachrymals; these do not develop outstanding supraorbital processes, and are not conspicuous from this aspect of the skull. There is no trace of the fusion of the frontal and nasal bones.

In the Musophagi the temporal fossæ are not strongly marked, and are confined to the lateral aspect of the skull. The parietal region is more rounded than in the Cuculi; and in *Turacus* is marked by a median furrow, so that the form of the cerebral hemispheres is distinctly indicated. In other respects this region of the skull resembles that of the Cuculi.

The Base of the Skull.

The basitemporal plate, in the Cuculi, is flattened and triangular in shape, and with the apex lying immediately beneath the Eustachian apertures. Posteriorly it is bounded by a precondylar fossa, which, though generally barely perceptible, in *Eudynamys*, *Centropus*, and *Geococcyx* is fairly deep. The lateral angles of the base are truncated, and, turning sharply downwards, cross the paroccipital notch to form the lower portion of the rim of the mouth of the tympanic cavity. In some genera, e. g. *Coua*, *Guira*, these downwardly-directed angles are very prominent and simulate mammillary processes.

The two sides of this triangular plate have fused with the ossified connective tissue forming the anterior wall of the recessus tympanicus anterior. Consequently the Eustachian grooves have been converted into tubes opening directly above the apex of the triangle.

The parasphenoidal rostrum bears slight vestiges of basi-pterygoid processes in *Eudynamys* only among the Cuculi.

The rostrum is relatively long, and curves slightly upwards.

In the Musophagi the basitemporal plate, like that of the

Cuculi, is triangular; but it differs from the Cuculine plate in that it is somewhat swollen, a feature which is especially well-marked in *Schizorhis*. The two sides of the triangle are produced backwards over the paroccipital notch to join the lateral occipital wing of the tympanic cavity: thus they come to project beyond the base of the triangle, though they are less conspicuous than in some of the Cuculi. There is a barely perceptible precondylar fossa.

The Lateral Aspect of the Cranium.

The tympanic cavity is oval or oblong in form and of moderate size. It is bounded in front by the quadrate, behind by the lateral occipital tympanic wing, below by the basitemporal plate, and above by the squamosal prominence and by the head of the quadrate.

Within the mouth of this cavity lie several smaller apertures. The largest of these is that of the *recessus tympanicus anterior*. Immediately below this is the mouth of the Eustachian tube. The foramen ovale and foramen rotundum, three foramina of the sinus petrosus, and the mouth of the posterior tympanic recess open into the cavity by a common aperture—the *fenestral recess*—which is very small, and lies mesiad of the articular surface for the otic head of the quadrate. The mouth of the posterior tympanic recess is completely concealed, and can only be made out by cutting away its outer wall and passing a bristle through from its cavity into the common aperture of the foramina in question. In some birds, e. g. *Falco*, the posterior tympanic recess communicates with the tympanic cavity by two apertures—one caudad of the foramina ovale and rotundum, and lying within the fenestra through which these are approached; and the other external to this fenestra, separated therefrom by a bony column, and lying immediately beneath the articular surface for the otic head of the quadrate. This external aperture is wanting in the Cuculiformes. Immediately above the head of the quadrate, and between the otic and squamosal heads, will be found the aperture of the superior tympanic recess, which is reduced in this group to extremely small dimensions. The foramen of the 7th (facial nerve) opens also into the tympanic cavity between the otic articular surface for the quadrate and the rim of the anterior tympanic recess.

The squamosal and otic articular surfaces for the quadrate form a dumbbell-shaped area immediately in front of the aperture of the superior tympanic cavity. The actual articular surfaces are formed by the expanded ends of the dumbbell only. Where the pneumatic area is very large, as in the Striges and Falconiformes for example, it breaks through the connecting portion of these two articular surfaces so that they become quite isolated.

The Squamosal Prominence.—The size of this prominence depends largely upon the development of the temporal fossa. When this is deep the prominence is large; but when shallow the prominence is quite inconspicuous. Its anterior angle is produced

forwards into a more or less well-developed spine, the *processus zygomaticus squamosi*. The base of this angle serves for the articulation of the squamosal head of the quadrate. This zygomatic process is especially well-developed in *Cuculus*, *Crotophaga*, and *Geococcyx*. It is small in *Guira* and *Coua*, for example, and in the Musophagi. The *processus articularis squamosi* is wanting.

The temporal fossæ are never very deep, but they may extend inwards to within a short distance of the middle line. The variations in the extent of these fossæ have already been dealt with (*supra*, p. 260).

The *trigeminal foramen* in the Cuculi lies immediately above the mouth of the anterior tympanic recess, on a level with, and in front of, the otic articular surface for the quadrate. In *Turacus* this foramen is divided by a median vertical bar of bone.

The orbito-nasal foramen (v^1) appears to be definite only in *Geococcyx*. In other *Cuculinæ* and *Musophaginæ* the alisphenoidal wall only partially ossifies, and consequently this and other foramina around the optic foramen disappear in the dried skull.

The *orbits* are large, and roofed by moderately broad overhanging ledges formed by the frontals, and to a slight extent by the lachrymals. The *orbito-sphenoid* does not ossify.

The *interorbital septum* in the Cuculi is generally pierced by a large fenestra, which attains its maximum in *Dromococcyx* and *Centropus*. In *Crotophaga*, *Coua*, *Piaya*, *Rhamphococcyx*, *Rhinococcyx*, *Rhopodytes*, and *Zanclostomus*, however, the fenestra is greatly reduced.

In the Musophagi the fenestra is large in *Turacus*, small in *Schizorhis*. I have not had an opportunity of examining other genera.

The orbit is bounded in front by the antorbital plate (p. 263).

The *lachrymal* in the Cuculi is moderately large, with subequal supraorbital and descending processes. The form of this bone and its relation to the frontal and nasal bones vary considerably however. In *Rhamphococcyx calorhynchus* only, apparently, is it attached merely to the nasals. The orbital process looks entirely forwards, instead of upwards: that is to say, it forms a shield for the front of the eye instead of an overhanging ledge therefor; the descending process is slender. The frontals rest on the inner angles of the orbital process of the lachrymal on either side, and appear, in the adult skull, to be cut off from the nasals and premaxillary process by a sharply-defined groove, which runs across the skull from the hinder edge of the orbital process up the lachrymal on the one side to that of the other, and simulates a nasal hinge. *Rhinococcyx curvirostris* apparently closely resembles *Rhamphococcyx*, but the lachrymal being completely fused with the nasals and the frontal behind it, the precise relations of the various regions cannot be made out.

In other Cuckoos, though exhibiting a distinct tendency to form an anterior shield rather than a pent-house ledge, the

lachrymal extends backwards for some distance over the frontals. In *Eudynamys* the frontals are deeply notched to receive the orbital process of the lachrymal, which is more or less diamond-shaped. In other genera the orbital process of the lachrymal may be semilunar or rod-shaped. Where the antorbital process is very large, the descending process of the lachrymal is always more or less markedly degenerate. In *Cuculus* it has disappeared altogether, whilst the orbital process has fused with the frontal and nasal bones. In *Zanclostomus javanicus* it is reduced to a mere vestige. The descending process is unusually large in *Crotophaga*, one of the genera, it will be remembered, with a small antorbital process.

Geococcyx has the largest lachrymal of all the Cuckoos. It is nearly columnar in form, flattened antero-posteriorly, and deeply grooved immediately above the quadrato-jugal bar.

The lachrymal in the Musophagi in its general shape closely resembles that of the Cuculi: the orbital process is, however, inclined more upwards. The descending process, judging from what obtains in *Schizorhis* and *Musophaga*, is fairly strongly developed. In *Schizorhis* the free end of the descending process is twisted in itself, rests upon the quadrato-jugal bar, and articulates by its postero-internal angle with the enormous *ossiculum lachrymo-palatinum*.

The *lachrymo-nasal fossa* varies considerably in size. Among the Cuculi, it may be described as large in *Eudynamys*, *Centropus*, *Guira*, and *Crotophaga*. In *Coua*, *Rhamphococcyx*, and *Geococcyx*, for example, it is extremely reduced by the encroachment of the lachrymal.

The Ethmoidal Region.—The *mesethmoid*, both in the Cuculi and the Musophagi, terminates abruptly immediately in front of the antorbital plate. The horizontal plate formed by the expansion of its dorsal border is but feebly developed.

The *antorbital plate* (prefrontal), which, with the lachrymal, bounds the orbit in front, is, in some Cuculi, e. g. *Cacomantis*, *Centropus*, *Coua*, *Coccystes*, *Cuculus*, *Eudynamys*, *Geococcyx*, *Piaya*, *Taccocoua*, and *Saurothera*, conspicuously large, quadrate in form, and has its dorsal border pierced by two foramina—an inner for the passage of the olfactory nerve, and an outer for the orbito-nasal (v^1).

In other forms, e. g. *Guira*, *Crotophaga*, the antorbital plate, though large, has the external lateral and inferior borders deeply excised. In such cases the orbito-nasal foramen described above is represented by a notch. Attached to the inferior border of this plate is a vestigial *ossiculum palatinum*, which, however, is generally wanting in dried skulls.

In the Musophagi the antorbital plate is greatly reduced, forming but a triangular process projecting from the mesethmoid. From its inferior border depends a well-developed *ossiculum lachrymo-palatinum*. In *Schizorhis* this bone is relatively enormous, projecting downwards to articulate by a strap-shaped

limb with the outer border of the palatine. Its further relations with the lachrymal will be discussed presently.

The nasal septum is completely ossified, and the external nares are in consequence imperforate. The ectethmoidal region presents several points for comment. By the ossification of the alinasal wall, the form of the external nares is greatly changed in many of the Cuculi. In consequence of this ossification, the space between the premaxillary and descending processes of the nasal becomes obliterated. Thus in *Geococcyx* the nostrils take the form of an oval aperture lying just cephalad of the middle of the beak. In *Rhamphococcyx* this aperture is still further reduced, and consists only of an elongated slit lying at the base of the beak above the tomium. In *Rhinococcyx* the aperture is nearly circular at the base of the beak, and bounded by a deep groove in front. The alinasal ossification is, however, imperfect, inasmuch as a small round hole is left in the angle between the premaxillary and descending processes of the nasals. In *Taccocoua* this superior foramen and the aperture of the nostril have blended.

In *Coua* the floor of the anterior region of the nasal fossa is raised up into a sharp longitudinal ridge.

In the Musophagi the form of the external nostril differs conspicuously from that of the Cuculi. It is situated slightly distad, or proximad, of a line passing through the middle of the beak, and is reniform in shape. In *Turacus* it lies distad, in *Schizorhis* proximad of the middle line. In both genera, just within the mouth of the aperture, lies a well-developed *concha vestibulum*. This is especially large in *Schizorhis*. Furthermore, the genus is peculiar in that immediately distad of the concha the nasal septum is pierced by a minute foramen.

The Cranial Cavity.—The *metencephalic fossa* is somewhat shallower in the Musophagi than in the Cuculi. The *internal auditory meatus* in the Cuculi is sharply defined, strongly contrasting in this respect with the Musophagi, in which it is but ill-defined. The vagus foramen, which lies caudad and ventrad of the meatus, is small. The *orbito-nasal foramen* (v^1) pierces the outer superior rim of the fossa near the outer angle of the *dorsum sellæ*.

The *cerebellar fossa* is relatively smaller in the Cuculi than in the Musophagi, and in both it is relatively smaller than in many other groups, *e. g.* Falconiformes. In the Cuculi the floccular fossa is very shallow, and lodges a deep slit-like vertical depression. In the Musophagi this fossa is reniform, deeper, and lodges a deep and wide depression which gives the reniform character to the whole.

The *mesencephalic fossa* is fairly sharply defined in both groups. Among the Cuculi, this is especially noticeable in *Geococcyx*. Its floor, in both groups now under consideration, is pierced by the trigeminal foramen. The difference in position of this foramen is worth noticing. In the Falconiformes it lies, together with the orbito-nasal (v^1), in a pit carved out of the superior border of

the metencephalic fossa, midway between the sella turcica and the floccular fossa, and is overhung by a sharp ledge formed by the inferior border of the *metencephalic fossa*.

The *pituitary fossa* is large, deep, and tubular. The hinder border of the fossa—the *dorsum sellæ*—forms a tumid lip. Anteriorly the fossa is bounded by the *pre-pituitary ridge*, which forms a broad triangular *optic platform*. This platform is carried far forward into the interorbital septum, rising gently in its course, and then turning abruptly backwards to terminate at the *pre-optic ridge*, which may be traced into the tentorial ridge. The form of the optic platform contrasts strongly with that in some other types, *e. g.* Accipitres. The *tentorial ridge* in the region of the pre-optic platform is but feebly developed. On the parietal wall, however, it becomes tolerably distinct, especially in *Geococcyx* and the Musophagi. In these, on its way to the median falx it meets, near the crest of the epiotic, the sharply-defined internal border of the mesencephalic fossa, and forms therewith a prominent angular boss of bone, especially well marked in *Geococcyx*. The bony falx is not very strongly developed.

The *oculo-motor* (iii.) and *abducens* (vi.) nerves leave by a common aperture, forming a deep groove across the posterior angles of the optic platform.

The *cerebral fossæ* lie quite in front of the cerebellar fossa, and are more flattened dorso-ventrally in the Cuculi than in the Musophagi.

The *olfactory fossæ* are relatively feebly developed.

The Premaxilla.

The external, as distinguished from the palatal, portion of the upper jaw is made up mainly by the premaxilla. This region of the jaw, in the Cuculi and Musophagi, varies considerably in form. Normally, it may be described as about as long as the cranium. In *Crotophaga* it is slightly longer than this, in *Geococcyx* and *Saurothera* very much so. Typically, it may be described as hemicrescentic in outline, depressed from above downwards, and tapering from the base forwards. In *Geococcyx* and *Saurothera* it is long and pointed; in *Crotophaga* surmounted by a sharp, high keel; in the Musophagi more or less inflated.

The premaxillary portion of the jaw is slightly decurved at the tip, and the palatal surface is level with the culmen. The nasal processes of the premaxilla fuse completely with the nasals.

A nasal hinge occurs in *Turacus* among the Musophagi, but is wanting in the Cuculi.

The Maxillo-jugal Arch.

The maxilla is indistinguishably fused with the premaxilla. The maxillo-palatine processes are expanded horizontally, and meeting the ventral border of the nasal septum in the middle line, form an indirectly desmognathous palate.

Among the Cuculi, the least specialised palate is probably to be found in *Coua* and *Eudynamys*. In *Coua* the maxillo-palatine processes are widely separated and spongy in character; the consequent palatal vacuity is filled by the nasal septum, which is also spongy in character, and, fusing with the maxillo-palatine on either side, forms an indirectly desmognathous palate. *Eudynamys* closely resembles *Coua* in this respect, but the bony tissue is less spongy, and the fusion between the palatine processes and nasal septum is more complete. *Cuculus*, *Guira*, and *Centropus* resemble *Eudynamys*. Further specialisation of the palate is seen in the still further obliteration of the boundaries between the maxillo-palatines and the nasal septum, and the tendency to shorten and broaden the palatines. Forms like *Geococcyx* and *Rhinococcyx* show how these modifications have come about, whilst in *Rhamphococcyx* we may see the maximum development of these peculiarities.

In the Musophagi the maxillo-palatines never appear to completely coalesce in the middle line, nor does the nasal septum descend to the level of the ventral surface. The palate is nevertheless desmognathous, since this septum fuses with the dorsal surfaces of the maxillo-palatines.

No separate elements can be distinguished in the quadrato-jugal bar.

In the Cuculi the quadrato-jugal bar is almost or quite continuous with the tomium of the maxilla: in the Musophagi, on the contrary, it rises considerably above the level at its distal end. This difference is due to the fact that in the Cuculi the floor of the maxillo-palatine process lies low, being only just raised above the palatines at its postero-external angle, whilst in the Musophagi this region is raised high above the palatines.

The Vomer, Palatines, and Pterygoids.

The *vomer* is absent in the Cuculi, vestigial in the Musophagi. In the latter group it is spicular in form and fused with the palatines, which it joins by means of a pair of very short limbs. Anteriorly it touches the nasal septum.

The *palatines*, in the Cuculi, vary in shape. In the less specialised forms, such as *Eudynamys*, *Coua*, *Guira*, they are moderately long, and exposed slightly outwards. Anteriorly, from the level of the forward face of the antorbital plate to the point of fusion with the maxillo-palatines, the shaft of each is rod-like; cephalad of this point the bone spreads out into a moderately broad blade, the postero-external angles of which are rounded off, whilst the mesial border is produced ventrad to form a more or less pronounced keel. In *Cuculus* there is but little difference in the width between the anterior and posterior moieties, and the shaft is nearly straight.

In the heavy-billed forms like *Rhamphococcyx* and *Rhinococcyx* the palatines are relatively shorter, and have the maxillo-palatine extremity laminate instead of rod-like. The skull of *Scythrops*, I regret to say, is not contained in the National Collection.

In all the Cuculi, the palatines meet one another in the middle line immediately beneath the parasphenoidal rostrum, which they grasp laterally through their fusion with the hemipterygoids.

In the Musophagi the palatines are relatively longer than in the Cuculi, from which they also differ in that they *taper*, instead of *broaden*, rapidly as they approach the pterygoids. Furthermore, they do not meet below the parasphenoidal rostrum, but, on the contrary, are separated one from another by the whole width of this rostrum (Pl. XXII. fig. 2). The dorsal surface of the pterygoid end sends up a long and deep, incurved keel, the antero-internal angles of which fuse with the vestigial vomer.

The *pterygoids*, in the Cuculi, are moderately long and straight, and in some, e. g. *Crotophaga*, *Rhinococcyx*, *Guira*, *Taccocoua*, have the dorsal border raised up into a high, sharp crest, the palatine end of which embraces the parasphenoidal rostrum, whilst in *Eudynamys*, *Coua*, *Geococcyx*, and *Piaya*, for example, this crest is absent. The palato-pterygoid articulation is in the form of an obliquely transverse hinge-joint, permitting only a lateral motion. Basipterygoid facets are absent.

The *hemipterygoid* element of the pterygoid is conspicuous only in *Taccocoua* and *Geococcyx*. Herein it forms a continuation of the dorsal crest of the shaft of the pterygoid, and rests on the palatine at a slight angle. Secondary fusion between the hemipterygoid and the main shaft of the pterygoid would reproduce exactly the conditions of the palato-pterygoid articulation which obtain in the *Bucconidæ* and *Momotidæ*.

In the Musophagi the pterygoids are relatively short, somewhat twisted, rods, bearing vestiges of basipterygoid facets. They articulate with the palatines as in the Cuculi.

The Mandibles.

The mandible in the Cuculi has a short, blunt angular process, and a moderately long internal angular process.

In *Eudynamys*, *Cuculus*, and *Guira* the rami are pierced by a long lateral vacuity, which is partly closed by a long and slender coronoid. In *Coua* the coronoid terminates midway across this vacuity; whilst in *Taccocoua* and *Centropus* this vacuity is quite open, the coronoid forming its ventral border. In *Piaya*, *Rhinococcyx*, and *Rhamphococcyx* the ramal vacuity is absent. In *Geococcyx* it is partly closed anteriorly by the hinder end of the splenial.

The mandible of *Cuculus* possesses one conspicuous feature in the presence of a triangular flange of bone formed by the deflection of the superior border of the ramus at the point corresponding, in the living bird, to the gape, in the skeleton to the region immediately behind the lachrymo-nasal fossa. The flange, especially conspicuous in *Cuculus canorus*, is also fairly distinct in *Cacomantis*, and is traceable in *Piaya* and *Rhamphococcyx*. The internal angular process is well marked in all the Cuckoos, but is especially so in *Coua* and *Centropus*.

In the Musophagi the *angular* is sharply truncated posteriorly, and the internal angular process is short and blunt.

In *Schizorhis* the ramal vacuity is closed posteriorly, in *Turacus* it is closed completely, by the coronoid.

The Hyoid.

Unfortunately the hyoid bones have been preserved only in one or two of the skeletons of this group in the Museum Collection. Years ago, when these skeletons were made, according to the prevailing custom, the hyoid bones were not regarded as of value.

In *Scythrops* the basihyal is slender and rod-shaped; the 1st basibranchial triangular, with concave sides, the 2nd of medium length, styliform and tapering. The ceratobranchial and epibranchial are subequal in length and offer no points for special comment.

In the Musophagi the basihyal bones are reduced to mere vestiges. The 1st and 2nd basibranchials are short and fused. The ceratobranchials are only slightly longer than the epibranchials.

iii. The Skull of the Nestling.

The National Collection of nestling skulls of this group is extremely limited, containing only one skull of *Cuculus canorus* and one of *Geococcyx californianus*. A series of skulls of nestlings and of immature individuals of various species of Cuckoos, as well as of Plantain-eaters, would be a useful addition to the Collection. At present the latter contains no skeletons of nestling Plantain-eaters and few skeletons of adults.

a. *Cartilage-bones.*

The *basioccipital* is somewhat linguiform in shape, and widens gradually from behind forwards. It is bounded on either side by the lateral occipitals, in front by the basitemporal plate. Its posterior border forms the greater portion of the occipital condyle.

The *exoccipital*, or lateral occipital, viewed externally, takes the form of a broad horizontal plate bounding the basioccipital on either side, and extending backwards and outwards, expands into a fan-shaped plate, the superior half of which is wedged in between the supraoccipital, parietal, and squamosal, whilst the ventral, or downwardly directed, moiety forms the posterior boundary of the tympanic cavity. The lateral segment of the foramen magnum is formed by the horizontal plate of the lateral occipital, which also, by the way, forms the extreme outer angle of the occipital condyle. The fact that the exoccipital comes into contact with the parietal is noteworthy: a similar relationship obtains also in *Dromæus* among the Palæognathæ, and will doubtless be found among several other Neognathine forms. The exoccipital is only just visible, from the cranial cavity being overlaid by the opisthotic.

The *supraoccipital* is extremely short antero-posteriorly, and is deeply cleft in the middle of its superior border. Its external lateral border fuses with the lateral occipital; within the cranial cavity it is bounded by the epi- and opisthotic. The small size of the supraoccipital recalls the skull of the Owls, but this of course is but a coincidence. The character will doubtless be found to obtain in the Kingfishers, Bucconidæ, and Capitonidæ, which have many characters in common with the Cuckoos.

The *proötic* does not appear externally. Within the cranium it occupies considerable space, forming the floor of the mesencephalic fossa, as well as a considerable portion of the lateral walls of the basin-like metencephalic fossa. It entirely excludes the squamosal from the cranial cavity.

The *epiotic* is only partially ossified, and in such a way that its boundaries cannot be made out.

The *opisthotic* has fused completely with the proötic.

The *basisphenoid* is not visible externally, being underlaid by the basitemporal plate. Concerning its internal boundaries, nothing satisfactory can be gathered from the two skulls in the National Collection, the younger being damaged, whilst in the more adult skull it has fused with the neighbouring bones.

The *alisphenoid*, in the younger of the two skulls, is not yet completely ossified. As a result, between the external ventral angle and the squamosal there is a wide gap, which extends inwards below the inferior alisphenoid border, dividing its outer moiety from the basisphenoid. This gap, when viewed from without, is seen to be filled up by the proötic. Its supero-external angle is produced outwards to form the postorbital process.

The *orbito-sphenoid* is not yet ossified in these skulls.

The *presphenoid* has fused with the *basisphenoid*.

The *mesethmoid*, in the two skulls now under consideration, is yet incompletely ossified, forming but a linguiform plate; the interorbital septum formed by the backward extension of the mesethmoid having been represented only by cartilage. The anterior border of the linguiform plate is sharply truncated so as not to extend beyond the level of the free end of the parasphenoidal rostrum below and the anterior extremities of the frontals above. This truncation occurs at the cranio-facial fissure, which has cut the mesethmoid into two parts: the one forming the linguiform plate just described, which ultimately forms the interorbital septum; the other, the *septum nasi*, which in these skulls is yet cartilaginous.

The cranio-facial fissure appears to be peculiar to the neognathine (*Carinate*) skull; but traces thereof are apparently to be met with in the Palæognathæ (Ratitæ), inasmuch as, in the skulls of nestlings of *Dromæus* and *Rhea* in the Museum Collection, the ossification of the mesethmoid commences, as in the Neognathæ, by the formation of a more or less linguiform plate, and this has its superior border deeply excised, at a point exactly corresponding

to the vertical face of the posterior division of the neognathine mesethmoid, that is, exactly in front of the antorbital plate of the adult. To make the fissure complete, the incision would have to be continued downwards so as to completely bisect the plate, whilst the rostrum would have to terminate at the free edge of the posterior segment of the plate. In the adult skulls the incipient fissure remains, placing the right and left olfactory chambers, in the dried skull, in communication. The formation of a complete cranio-facial fissure is correlated with, and perhaps consequent on, the reduction in the length of the parasphenoidal rostrum, which in all the Palæognathæ is of great length. In a skull of a half-grown *Casuarius salvadorii* it is, however, relatively much shorter than in an adult *C. australis*, and much overhung by the mesethmoid. Whether this peculiarity obtains also in the adult of this species I am unable to say.

The *olfactory cavities* do not extend backwards in the Cuculi or Musophagi, so as to lie on either side of the mesethmoid, as in the Tubinares for example; the antorbital plate arising in the plane of the cranio-facial fissure.

The *quadrate* does not differ materially from that of the adult.

The *articulare* is still distinct.

b. *The Membrane-bones.*

The *parietal* is oblong in shape, its anterior and posterior borders sinuously curved, its mesial border straight, and its external lateral border being slightly convex. It is bounded in front by the parietal, behind by the supraoccipital, and laterally by the squamosal.

The *frontal* has its hinder border sinuously curved, and throughout the greater part of its length applied to the parietal. Its postero-external is closely applied to, and ultimately fuses with, the supero-anterior angle of the squamosal and the post-orbital process of the alisphenoid. In the supraorbital region it turns downwards and inwards to form a broad overlapping plate articulating with the alisphenoid. From the mid-orbital region onward it becomes band-shaped, ultimately being produced into an outwardly directed and blunt angle underlying the nasal.

The *squamosal* is roughly quadrate in form, and has the superior anterior angle produced into a linguiform process which overlaps the parietal and alisphenoid. Its antero-ventral angle is produced into a small squamosal prominence, the under surface of which affords the articular surface for the squamosal head of the quadrate. The postero-ventral angle is obliquely truncated, and forms the anterior segment of the rim of the tympanic cavity. The supero-posterior angle is produced into a slight point which is wedged in between the parietal and lateral occipital. The hinder border of the squamosal serves to cover in the *recessus tympanicus superior*, which is formed by the absorption of the diploë of the lateral occipital.

Internally the squamosal appears to be visible only in *Cuculus canorus* and *Centropus*, where it appears as a small triangular plate wedged in between the proötic, parietal, and alisphenoid.

The *nasal*, judging from the scanty material at my disposal, differs slightly in form in different genera, inasmuch as in *Cuculus* and *Centropus* it is not sufficiently large caudad to cover the horizontal plate of the mesethmoid. In *Centropus* the hinder border is produced into a sharp angle, and is rounded in *Cuculus* and *Geococcyx*. The nostril is holorhinal.

The *lachrymal* offers no special features for comment.

The *premaxilla* is fully ossified only in the skull of *Geococcyx*. Its nasal processes are long and slender, and the median suture dividing them extends far beyond the level of the anterior border of the nasal fossa. The maxillary and palatine processes lie close together and parallel with one another.

The *maxilla* in *Geococcyx* is elongated and triangular in form, and sends backwards from its postero-external angle a long slender bar to join the jugal and quadrato-jugal. The body of the maxilla is slightly spongy and has the postero-internal angle produced backwards and inwards into a maxillo-palatine process. The body of the maxilla lodges a barely perceptible antrum.

The *quadrato-jugal* is long and slender in *Geococcyx*; the relations between the jugal and maxilla cannot be made out, the skull having become disarticulated.

The *vomer* is absent.

The *palatine* does not differ appreciably from that of the adult.

The *pterygoid* is rod-shaped, and produced forwards into a sharp triangular spine (Pl. XXII. fig. 10), which articulates with a corresponding facet in the mesial border of the palatine. Later this triangular process becomes segmented off from the main shaft to form the hemipterygoid, which ultimately fuses with the palatine. At the present stage this segmentation is faintly indicated by a shallow furrow on the outer surface of the shaft. In the adult, where the fusion with the hemipterygoid is complete, the palato-pterygoid articulation is formed by the approximation of glenoid surfaces sloping obliquely backwards.

The *dentary* and *splenial* do not differ from those of the adult.

The *coronoid*, *angulare*, and *supra-angulare* are all as yet distinct.

iv. The Vertebral Column.

The vertebral column of the Cuculiformes is not marked by the same constancy of character which is so conspicuous in the skull. In many respects it recalls that of the Coraciiformes, but even among the Cuculi relatively wide differences obtain.

All the presynsacral vertebræ are heterocœlous, and all the thoracic vertebræ are free.

The cervicals of the smaller Cuculi recall those of *Leptosoma*.

The *odontoid ligament* of the atlas is ossified. The axis vertebra is very short antero-posteriorly, and has the neural arches produced

outwards and upwards into a pair of pointed hyperapophyses. The neural arches of the vertebræ, from the third to the fifth inclusive, are very broad, and with or without spines. From the third to the sixth or seventh vertebræ large metapophyses occur, those of the fourth, fifth, and sixth being especially large, projecting like buttresses from the base of the anterior zygapophyses. The metapophyses of the third vertebra send back each a slender bar of bone to join the hyperapophysis. A similar bar of bone occurs also from the fourth to the seventh vertebræ, but instead of joining the hyperapophysis, fuses with the antero-lateral angle of the shield-shaped expansion formed by the neural arch. The succeeding cervicals do not afford any particularly well-marked characters in so far as this region is concerned.

The anterior cervicals of *Scythrops* and *Cuculus* (1 to 7) differ from those of the Cuckoos just described in that they are relatively slightly longer antero-posteriorly, that the bony bar from the metapophysis to the hyperapophysis occurs only in the 3rd vertebra, and in that the shield-like expansion of the neural arches is very feebly developed. Short neural spines occur in the 2nd, 3rd, and 4th vertebræ.

The 2nd, 3rd, and 4th vertebræ bear hypapophyses; from the 5th to the 10th these are replaced by catapophyses, which from the 11th vertebra backwards to the last cervico-thoracic are replaced again by hypapophyses. The cervico-thoracic vertebræ are peculiar in that they bear more or less well-developed catapophyses in addition to the median hypapophysis. The catapophyses never coalesce to form a carotid canal.

The cervico-thoracic vertebræ may be two or three in number. The number of the true cervicals varies, being either 11 or 12.

The thoracic vertebræ are free. The 1st or 1st to 3rd, as in *Eudynamys* and *Coua* for example, bear hypapophyses. Pneumatic foramina pierce the centra of the vertebra beneath the transverse processes.

The neural spines of these vertebræ gradually increase in height from before backwards, and are more or less quadrate in form. *Coua*, however, appears to form an exception to this rule, the spine of the 1st thoracic being almost obsolete, and thus agreeing with the cervico-thoracic vertebræ; whilst the spines of the 2nd, 3rd, and 4th vertebræ are, relatively, as high as in other Cuckoos.

The last two cervico-thoracic (2nd and 3rd) have apparently only recently become separated from the thoracic series, inasmuch as the vertebral segments of their respective ribs have undergone no reduction in length. The ribs of the third pair still retain their uncinate processes.

Only one thoracic vertebra, in the Cuculi, enters into the synsacrum.

The synsacrum includes from 10 to 13 vertebræ. The smaller number appears to have been due to the reduction, possibly by excalation, of the lumbar or lumbo-sacral vertebræ, or of caudal vertebræ, as in *Geococcyx*.

The most complete synsacrum is that of *Coua*, and is made up as follows:—1 thoracic, 3 lumbar, 3 lumbo-sacral, 2 sacral, and 4 caudal, making 13 in all.

Rhopodytes seems to possess the most reduced synsacrum: the number of thoracic, lumbar, and sacral is the same as in *Coua*, but the lumbo-sacrals are reduced to 1 and the caudal to 2: making therefore a total of 9 vertebræ as against 13 in *Coua*.

Crotophaga and *Geococcyx* each have 11 vertebræ in this region. In the former, the reduction is from the lumbo-sacrals, which are only represented by a single vertebra; in the latter there are 2 lumbo-sacrals, but only 3 caudals.

In other genera, the number of vertebræ appears constantly to be 12, composed as follows:—1 thoracic, 4 lumbar, 1 lumbo-sacral, 2 sacral, and 4 caudal.

In no case can distinct sacral vertebræ be made out. The synsacrum of *Rhamphococcyx* is remarkable in that the single lumbo-sacral vertebra bears a pair of exceptionally strong ventri-lateral processes. Vestiges of these appear in *Scythrops*, *Coua*, and *Taccocua*.

In *Centropus* the third and fourth pairs of ventri-lateral processes are apparently undergoing coalescence. In some skeletons this fusion is complete; in others traces, more or less marked, of the original buttresses still remain.

The last two caudal vertebræ combine to form a well-marked *planum anale*.

There are 6 or 7 post-synsacrals—free caudal vertebræ. Of these the 4th and 6th bear pointed intercentra, which, however, are completely fused with their respective centra.

The total number of vertebræ reaches its highest in *Coua* with 37.

The vertebral column of the Musophagi is scarcely distinguishable from that of the Cuculi.

The cervical vertebræ closely recall those of *Cuculus*. They may be distinguished therefrom, however, apart from their greater size, in that the 3rd and 4th both send backwards a bar from the meta- to the hyperapophysis, and in that the 7th and 8th send back a similar bar from the same region to the middle of the neural arch. There are only two cervico-thoracics. The vertebra corresponding to the third cervico-thoracic of certain Cuckoos, e. g. *Scythrops*, becomes in the Musophagi thoracic, being joined to the sternum by a sternal rib. The thoracic vertebræ differ from those of the Cuckoos, in that the transverse processes send backwards from their postero-external angles a long bony spike to overlap the transverse process of the vertebra next behind it. These connecting-rods are either wanting or very feebly developed in the Cuckoos, e. g. *Scythrops*.

The cervical vertebræ are 12 in number, the cervico-thoracic 2, thoracic 6, the last being fused with the synsacrum.

The synsacrum contains 13 vertebræ, and is made up as follows: thoracic 1, lumbar 3, lumbo-sacral 3, sacral 2, caudal 4.

The 1st lumbo-sacral shows vestiges of ventri-lateral processes. Only the 2nd sacral bears ribs.

There are 8 free caudals, but the 7th is nearly fused with the pygostyle. The total number of vertebræ is 41.

I must here point out that the determination of the sacral vertebræ in the skeletons herein described is a purely arbitrary one; they cannot possibly be determined with certainty without examination of the sacral nerve-plexus, and this I am unable, at the present moment, to make. Thus, it may be that the plexus will show that in some cases what is here described as the last lumbo-sacral in reality is the first sacral. If this should be the case then, of course, the vertebra herein described as the 2nd sacral would be the 1st caudal.

v. The Ribs.

The cervical ribs, in the Cuculi, form a series of very broad pleur-apophyseal lamellæ enclosing the usual vertebrarterial canal. These plates extend backwards rather beyond the middle of the centrum. Seen from the ventral surface, the rib is free for about half its length. Certain of the vertebræ in the middle of the cervical chain have this lamella pierced by a large fenestra. In *Guira*, *Coua*, *Centropus*, the 5th, 6th, and 7th are so distinguished; in *Crotophaga* the 6th, 7th, and 8th; in *Scythrops* the 7th and 8th; in *Taccocoua*, the 4th, 5th, and 6th. *Cuculus*, *Chrysococcyx*, and probably other smaller forms, differ from the forms just described in that the anterior cervical ribs are comparatively long and slender, not lamellate; whilst from the 7th vertebra backwards the ribs are reduced to vestiges.

The cervico-thoracic ribs number two or three pairs. The third pair always bear uncinates.

There are five pairs of thoracic ribs, though not more than four are attached to the sternum. The fifth pair are overlapped by the preacetabular ilium, and may be reduced to the merest vestiges, e. g. *Rhamphococcyx* and *Coua*, or they may be complete, as in *Scythrops* and *Cuculus*. They vary somewhat in form. For instance, in *Coua*, *Centropus*, and *Guira* the proximal end of the rib is extremely broad, and the shaft after leaving the vertebra almost at right angles, curves abruptly downwards. In other Cuckoos the broadening of the shaft is not conspicuous, and the shaft slopes gently downwards and backwards, so that the thorax is conspicuously broader at the articulation with the sternal ribs than above.

The uncinates are broad and strong, and show a tendency to develop a sharply defined postero-inferior angle at the junction with the shaft of the rib; this is especially noticeable in *Coua*.

The sternal segments of the 5th pair of thoracic ribs never reach the sternum. They may persist as vestiges, even the thoracic segment of the rib reaching the verge of disappearance, as in *Coua* and *Rhamphococcyx*, or they may be of considerable size,

and extend more than halfway down the sternal segment of the 4th rib as in *Scythrops*.

The sternal ribs of *Coua reynaudi* are relatively longer than in other Cuckoos, and this fact appears to be correlated with degenerate powers of flight. As a result of the lengthened rib-segments and a change in the angle formed by the corpus sterni and the vertebral column, to be discussed presently, the form of the thoracic cavity differs conspicuously from that of other Cuckoos and recalls features characteristic of "Ratitæ." These peculiar features are wanting in *Coua cærulea*.

The cervical ribs of the Musophagi closely resemble those of the Cuculi, taking the form of broad pleurapophyseal lamellæ. From the 5th to the 8th these lamellæ are fenestrated as in the Cuckoos, so that the lamella appears to be joined to the centrum by a slender bar of bone, the bar extending to the level of the base of the postzygapophysis. There are six pairs of thoracic ribs, five of which articulate with the sternum. The 6th pair are long, but have lost connection with their sternal segments, which remain as small spicules anchylosed with the sternal segment of the 5th pair. In the Cuckoos, it will be remembered, there are only 5 pairs of thoracic ribs, the 5th pair of which, like the 6th in the Musophagi, fails to reach the sternum.

vi. The Sternum and Shoulder-girdle.

The sternum of the Cuculiformes recalls that of the Coraciæ rather than that of any other group.

The sternum of the Cuculi may be readily distinguished from that of the Musophagi in that it is relatively conspicuously shorter, being indeed in many cases as broad as long. Moreover it appears to be undergoing yet further reduction.

The form of the posterior margin of the corpus sterni and the relative development of the *spina externa* present considerable variations.

With regard to the posterior margin of the sternum, this appears to be entire in *Cacomantis* only. Two extremely thin oval areas indicate, however, the presence originally of a pair of posterior lateral processes, the space between which and the median border of the metasternum has been filled up.

In *Scythrops*, *Cuculus*, *Coccystes*, *Guira*, *Centropus*, and *Crotophaga* the posterior border is interrupted by a single pair of notches, the outside of the notch being bounded by the posterior lateral process.

All the other genera appear to have a doubly notched sternum, but the character of the notches varies considerably. In *Piaya*, for example, the posterior lateral process arises directly behind the articulation of the 4th rib, and extends outwards and backwards to terminate in a spatulate extremity some distance cephalad of a line passing across the free border of the metasternum. Between this process and the metasternum is a straight *processus intermedius*,

which, like the external process, fails to reach the level of the metasternal border. In *Rhinococcyx*, *Rhamphococcyx*, and *Taccocoua* the posterior lateral process arises, as in *Piaya*, immediately behind the articulation for the 4th rib, but it forms a wider angle with the long axis of the sternum, and carries with it the intermediate process, so that it looks like a branch thereof. In *Coua* and *Geococcyx* the posterior lateral process leaves the sternal plate further back than in the forms just described. In other respects these two sterna are quite distinct.

In *Coua cærulea* the posterior lateral process is very broad, and extends backwards to the level of the posterior border of the metasternum, whilst the intermediate process is short and normally placed. *Coua reynaudi*, with an obviously degenerate sternum, differs from *C. cærulea* in that the posterior lateral process is slender, and the intermediate process shows a tendency to fuse with the base of the posterior lateral. In *Geococcyx* the posterior lateral process is long and slender, but fails to reach the level of the free border of the metasternum; whilst the intermediate process lies nearer the posterior lateral than the metasternum. Further, the sternum is peculiar in the great depth of the fissure on either side of the metasternum, giving this a long and narrow shape.

A conspicuous pointed *spina externa* is found in *Guira*, *Cuculus*, *Geococcyx*, and *Scythrops*. It is vestigial in *Centropus*. A small *spina interna* occurs in *Taccocoua*.

In *Rhamphococcyx* the *spina externa* and *interna* are both present, and fused to form a moderately large *spina communis*. In *Piaya*, *Rhinococcyx*, and *Coua* there is a vestigial *spina communis*. In *Cacomantis* the two spines remain distinct, but are extremely reduced.

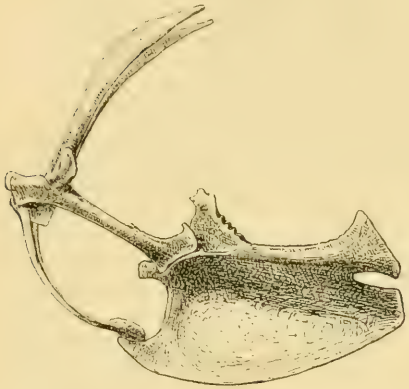
Both *spina externa* and *interna* are wanting in *Crotophaga*.

The *carina sterni* is relatively largest in *Cuculus* (text-fig. 43, p. 277), *Cacomantis*, and *Scythrops*. Its free ventral border is strongly arched, and its anterior border is deeply concave. The antero-ventral angle of the keel affords a firm articulation for the furcula. In *Coua*, *Rhamphococcyx*, *Crotophaga*, and *Piaya*, the anterior border of the keel is very deeply emarginate, causing the free border of the keel to project forward in the form of a long style. With the dorsal surface of the style the clavicle articulates by means of a long hypocleideum. Apparently the length of the hypocleideum is directly correlated with the retreat of the carina caudad. In the Galli this is well seen, the climax being attained in *Opisthocomus*.

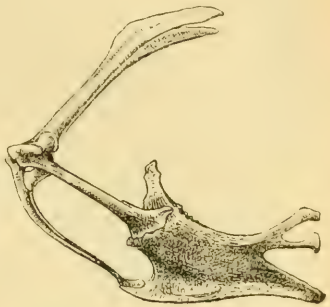
The depth of the carina is extremely reduced in *Coua reynaudi* (text-fig. 44, p. 277), so much so indeed that the power of flight in this species must be extremely limited. In other Cuckoos the depth of the carina is nearly or quite equal to half the breadth of the corpus sterni; in the species in question the greatest depth of the keel is barely one-fourth the breadth of the sternal plate. Correlated with the reduction in the keel and the consequent loss of flight, is a marked change in the position of the sternum, which

appears to have been thrust forward by a considerable increase in the length of the posterior sternal ribs. As a consequence, the shaft of the coracoid and the long axis of the sternum form nearly a right angle with the vertebral column, and the shaft of the scapula lies parallel with the vertebral axis, instead of forming an oblique angle therewith. This forward movement of the sternum, furthermore, has brought the acrocoracoid upwards to the level of the neural crests of the vertebræ, whilst the distance between the acetabulum and the free edge of the metasternum has been enormously increased. In fact, the thorax of this bird approaches very closely, in the relative position of the sternum, that of the "Ratitæ."

Text-fig. 43.



Text-fig. 44.



Text-fig. 43.—Left side view of sternum and shoulder-girdle of *Cuculus canorus*, to show the great size of the *carina sterni* and the form of the posterior border of the sternum.

Text-fig. 44.—Left side view of sternum and shoulder-girdle of *Coua reynaudi*, to show the degenerate *carina sterni*, which is actually more reduced than the figure indicates. Note also the long hypocleideum and the doubly notched corpus sterni.

Shortening of the sternum is most marked in *Piaya*, *Zanclostomus*, and *Taccocoua*.

The sternum of the Musophagi is relatively longer and more Coraciiform than that of the Cuculi, but is at the same time thoroughly Cuculine in character. In both *Turacus* and *Schizorhis*, the only genera represented in the National Collection, the hinder border of the sternum is doubly notched, and the notches are of considerable extent, the outermost being the deepest. The posterior lateral process is slender, and directed straight backwards. The intermediate process lies midway between the posterior lateral process and the metasternum. The outermost notch is about twice the depth of the inner.

The *corpus sterni* of *Turacus* is relatively much shorter antero-

posteriorly than in *Schizorhis*. The sternal notches of *Turacus*, it is to be noted, though preserving the same relative proportions between themselves, are yet relatively shallower than in *Schizorhis* with regard to their relation to the *corpus sterni*.

There is a well-developed *spina externa*, but no trace of a *spina interna*. In *Schizorhis* the spina is flabellate and projects from a rounded base. In *Turacus* it is quadrate in form. In *T. buffoni* it projects nearly as far forwards as the antero-ventral angle of the carina, and is distinguishable from the anterior border of the carina only through the medium of a notch. Were this notch filled up, the spina would disappear and the anterior border of the keel would present a vertical face projecting far beyond the coracoid grooves, as in certain Coraciiform birds, e. g. *Cyanops*.

The coracoid grooves overlap one another. The dorsal lip is extensive. A median notch occupies the place of the *spina interna*, and this is bounded on either side by a conspicuous oblong glenoid surface, which articulates with a special facet on the coracoid. In the Cuckoos the dorsal lip does not overhang the ventral, the coracoid grooves do not overlap nor in some cases even reach the middle line, and the oblong articular facet on the dorsal lip for articulation of the coracoid is only slightly developed. In the Musophagi the dorsal surface of the base of the spina externa affords articulation for the right coracoid; in the Cuckoos this is never the case.

In the Musophagi the articular surfaces for the ribs are fairly widely spaced, less so in *Turacus*; in the Cuckoos these surfaces are crowded together.

The *coracoid* in the Cuculi is relatively long and slender, being nearly or quite as long as the sternum. From the ventral aspect, one of the most conspicuous features is the large procoracoid. This forms a large oblong shelf projecting inwards and downwards from the shaft, at about the level of a line drawn across the shaft from behind the glenoid cavity. The acrocoracoid is large, and not twisted on the shaft so as to conceal the foramen interosseum. The processus lateralis is well developed and the *foramen supracoracoideum* is absent.

The *processus lateralis basalis* may be either broad and quadrate, with its antero-external angle produced forwards into a spine, as in *Cuculus*, *Rhopodytes*, *Eudynamys*, *Taccocoua*, *Rhamphococcyx*, *Scythrops*, and *Guira*; or narrow and directed outwards and backwards, as in *Centropus*, *Coua*, and *Dromococcyx*. In *Taccocoua*, and to a less marked extent in *Centropus*, the impression for the sterno-coracoideus muscle, on the dorsal aspect of the coracoid, is bounded in front by a sharp vertically directed spine.

The *scapula* is long and narrow, and differs somewhat in shape in the different genera; but the variations are unimportant, and not sufficiently large to justify description here. The acromion is short and stout, save in *Coua reynaudi*, wherein it is reduced in width to form a somewhat cylindrical process.

The *furcula* has long, round, slender limbs, gently arched. There is a moderately long and styliform hypocleideum in *Geococcyx*, *Coua*, *Rhamphococcyx*, and *Piaya*, for example. In *Crotophaga* it is spatulate. In *Centropus*, *Cuculus*, *Eudynamys*, and *Cacomantis* it appears to be of a degenerate spatulate type; whilst in *Scythrops* the hypocleideum appears to be wanting.

The nature of the combination of the elements forming the inner wall of the *foramen triosseum*—the acromion of the scapula, the procoracoid, and the free end of the clavicle—may prove, when exhaustively worked out, to have some slight value from a systematic standpoint. I propose, however, here to offer only a few remarks, selecting a few genera as examples.

In *Cuculus*, *Scythrops*, *Coua*, the whole free end of the furcula passes up cephalad of the acromion of the scapula and separates the latter from the procoracoid. In *Guira*, *Geococcyx*, *Rhamphococcyx*, *Rhinococcyx*, *Rhopodytes*, the acromion turns forwards so as nearly to join the procoracoid, and forms an opposing surface to the free end of the clavicle, which accordingly turns forwards to terminate in a point wedged in between the acromion and procoracoid. *Crotophaga* resembles *Guira* in this respect, but the free end of the clavicle is much broader and the articulation with the procoracoid more developed. In *Centropus* the acromion and acrocoracoid meet and embrace, as in a wedge, the styliform free end of the slender furcula. The procoracoid, which is large, does not come in contact with the scapula.

No two of the genera, however, exactly agree, but the differences between them are too slight to be described in words.

The coracoid of the Musophagi, though closely resembling that of the Cuculi, is yet readily distinguishable therefrom by the fact that the procoracoid turns downwards and outwards to fuse with the acrocoracoid, thus encircling the foramen triosseum with a continuous bar of bone. The procoracoid is large and passes insensibly backwards into the coracoid shaft, and there is a supracoracoid foramen. The *processus lateralis* is well developed, and directed outwards and upwards into a point. In the region where the pro- and acrocoracoid fuse there is an elongated facet for the articulation of the furcula. The procoracoid, however, appears to take the greater part of the share in furnishing this surface. On the dorsal or internal aspect of the coracoid there is developed a special articular surface for the dorsal lip of the coracoid groove of the sternum.

The *furcula* has relatively shorter, broader, and more laterally compressed limbs than in the Cuculi. A hypocleideum is wanting. The dorsal extremity bears a special projecting facet for articulation with the procoracoid.

The *scapula* resembles that of the Cuculi, but is relatively slightly broader and has a large acromial process.

The pro- and acrocoracoid meet and fuse one with the other, thus excluding the furcula from participation in the formation of the foramen triosseum.

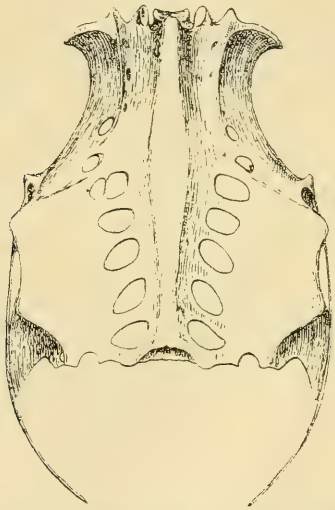
vii. The Pelvic Girdle.

The pelvic girdle of the Cuculiformes, though recalling in certain features that of the Coraciiformes, is yet quite distinct therefrom. Within the group it presents a comparatively wide range of form.

Among the Cuculi, the least specialised pelves are those of the smaller forms, such as *Cacomantis* (text-fig. 45) and *Chrysococcyx*.

In *Cacomantis* the preacetabular region of the ilia is separated by a low swollen ridge formed by the centra of the lumbar vertebræ. The dorsal border is nearly straight; the ventral, external, border is deeply emarginate; the anterior border truncated and rounded, curving outwards to form a hook-shaped antero-ventral angle. The postacetabular region of the ilium has

Text-fig. 45.



Dorsal aspect of the pelvis of *Cacomantis merulinus*, × 5, showing the widely separated preacetabular ilia, and the broad dorsal plane of the postacetabular region.

a broad dorsal plane which abuts against the long and slender transverse processes of the vertebræ. These last, by the way, are separated by a row of intertransverse sacral foramina, one on either side of the column. The dorsal plane of the postacetabular ilium is not produced outwards so as to overhang the ilio-ischiadic fissure, and its postero-external border is markedly depressed, not forming an upturned crest as in forms to be presently described. That portion of the ischium which, by its upturned growth, converts the obturator fissure into a foramen is very narrow; below and behind the foramen the ischium is produced

backwards into an obliquely sloping bar. The *pubis* is long, slender, and much bowed and closely bound to the posterior half of the ventral border of the ischium, beyond which it extends for some considerable distance. The obturator foramen is bounded posteriorly by a broad bar of bone descending from the ischium and fusing with the pubis. The pectineal process is reduced to a vestigial condition.

In the form of the pelvis, *Cuculus*, *Coccystes*, *Scythrops*, differ but little, save in size, from *Cacomantis merulinus*. In *Scythrops*, however, the obturator foramen is not cut off posteriorly by the descent of a bony plate from the ischium. In all save *Cacomantis* and *Cuculus* the intertransverse sacral foramina are more or less completely filled up.

In *Rhopodytes* and *Eudynamys* the mesial border of the extreme anterior end of the preacetabular ilium rises to the level of the neural ridge as in *Geococcyx* (text-fig. 46, p. 282). In *Taccocoua* this elevated region extends somewhat further backwards and forms a quadrate plate, the free border of which is lightly applied to the neural crest. In *Crotophaga*, *Rhamphococcyx*, *Coua*, and *Piaya* actual fusion takes place between this plate and the synsacrum. In *Centropus* and *Dromococcyx* the relationship between the fused region of the ilium and the synsacrum has become still further modified, so that the extremity of the ilium has acquired a T-shaped form, the dorsal limb of the cross-piece bridging a widely open *canalis ilio-lumbalis*. A similar canal is of course formed in the other cases where the ilia meet the neural crest of the synsacrum, but it is inconspicuous.

Further modifications in the form of the pelvis are the enormous lateral expansion of the dorsal plane and the shortening of the pubis. In forms like *Crotophaga*, *Coua*, or *Rhamphococcyx*, the early stages of the first-mentioned modification may be studied. Passing through forms like *Centropus* and *Taccocoua*, we reach a climax in *Geococcyx* (text-fig. 46, p. 282). Herein the width across the dorsal plane equals the length of the synsacrum. This outward extension of the postacetabular ilium has resulted in the formation of a huge ledge passing far beyond the level of the antitrochanter, and finally, at its free edge, turning abruptly downwards and then suddenly upwards, backwards, and inwards, like a pair of wings, so that the surface of the dorsal plane acquires a peculiar saddle-shaped appearance. Seen from the side (text-fig. 47, p. 282) or from below (text-fig. 48, p. 282), this overhanging ledge forms an enormous penthouse above and slightly behind the ilio-ischiadic foramen. A similar modification obtains elsewhere only among certain Rails. It appears to be correlated with a terrestrial mode of life, these forms flying but little.

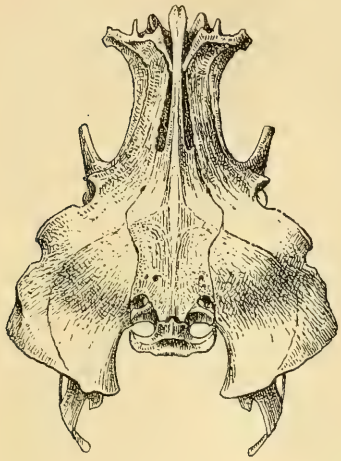
The shortening of the pubis is most marked in *Geococcyx*, *Piaya*, *Centropus*, and *Rhinococcyx*, and to a less extent in *Coua* and *Crotophaga*.

A large pectineal process occurs in *Geococcyx*, *Coua*, *Centropus*,

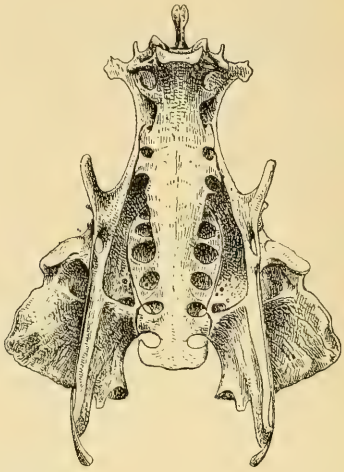
Rhamphococcyx, *Rhinococcyx*, and *Piaya*; it is small in *Rhopodytes* and *Taccocoua*, and vestigial or wanting in other genera.

The *fovea lumbalis* is very small, and the *fovea ischiadica* and *pudendalis* are confluent. There is a well-marked iliac recess.

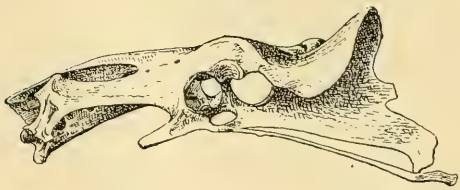
Text-fig. 46.



Text-fig. 48.



Text-fig. 47.



Text-fig. 46.—Dorsal aspect of the pelvis of *Geococcyx mexicanus*, showing the narrow preacetabular ilia, extremely broad postacetabular dorsal plane, and large pectineal process.

Text-fig. 47.—Side view of same, to show the broad ledge-like plate of the postacetabular ilium, the short pubis, and large pectineal process.

Text-fig. 48.—Ventral aspect of same, showing the great overhanging ledge of the dorsal plane. All figures of natural size.

The pelvis of the Musophagi resembles that of the more specialised Cuculi. Though relatively wide, its breadth is due rather to the great length of the synsacral transverse processes than to the dorsal plane of the postacetabular ilium. The preacetabular region of the ilium differs conspicuously from that of the Cuculi, inasmuch as in this group the dorsal aspect is so much cut away as to lie far below the level of the synsacral crest, save where it rises at the extreme antero-dorsal angle. In the Muso-

phagi, the preilium rises upwards and sweeps inwards in the form of a broad vertical blade with a gently rounded dorsal border, which ultimately meets and fuses with the synsacral crest, terminating in a truncated anterior border cephalad of the synsacral fusion. The *canalis ilio-lumbalis* is wide and spacious. The dorsal plane of the postacetabular ilium is moderately wide, and tapers posteriorly into a blunt, slightly upturned point. Its free outer border is somewhat thickened in *Turacus* to form a broad lip with sharply defined upper and lower edges; the inferior of these edges, immediately behind the ilio-ischiadic foramen, is produced into a blunt spine. In *Schizorhis* the free border of the dorsal plane is sharply defined, so that the blunt point caudad of the ilio-ischiadic foramen is apparent on the dorsal aspect of the pelvis, instead of below this level. The ilio-ischiadic foramen is relatively much smaller in *Turacus* than in *Schizorhis*. The ischium expands caudad into an extremely broad plate, especially so in *Turacus*. The free hinder border of this plate is slightly convex. In *Turacus* the obturator foramen is cut off from the fissure of that name by a descending plate of bone from the ischium. This is not the case in *Schizorhis*, the foramen and the fissure being confluent. The pubis is very long, attached for some distance posteriorly to the ventral border of the ischium. The pectineal process is large in both the genera in question.

The *fovea lumbalis* is larger than in the Cuculi, and the fovea ischiadica is distinct from the fovea pudendalis, the latter being cut up into separate compartments by the synsacral ventri-lateral processes. The iliac recess is fairly spacious.

viii. The Pectoral Limb.

The character of the wing is very uniform throughout the group. The humerus only is pneumatic. Most nearly resembling that of the Trogons in its general character, the limb of the Cuculiformes may be distinguished by the greater size of the pectoral crest of the humerus, which forms a linguiform or even triangular plate, and by the prominent *collum trochleæ*, the strongly bowed curve of metacarpal III., and the absence of a backwardly projecting spur on the upper $\frac{1}{3}$ of metacarpal II.

In the humerus the coraco-humeral groove (*sulcus transversum*) is wanting. The *crista superior* is gently arched, rising from the base of the *tuberculum externus* and terminating about the upper $\frac{1}{3}$ of the shaft. In some cases, e. g. *Crotophaga*, the pectoral crest may be more or less triangular instead of rounded. There is a very small ectepicondylar tubercle. The pneumatic foramen is small; the *incisura capitis* sharply defined. The humerus of the Musophagi may be distinguished from that of the Cuculi by the fact that in the former the proximal border of the crista superior is long, low, and concave, the distal border short and strongly arched.

In the Cuculi there is considerable variation in the relative

lengths of the segments of the wing. Thus, in *Scythrops*, the brachium and antebrachium are of equal length, whilst the manus is only a very little less in length than either of these segments. The brachium is longer than the antebrachium, and the latter is in turn longer than the hand in *Coua*, *Rhamphococcyx*, *Rhinococcyx*, *Eudynamys*, *Guira*, and *Crotophaga*. The relative disproportion between the length of the brachium and antebrachium is especially marked in *Dromococcyx* and *Piaya*. The brachium is longer than the antebrachium, but the latter and the manus are equal in length in *Centropus* and *Taccocoua*. In *Cuculus* and *Cacomantis* the brachium and manus are subequal and shorter than the antebrachium. In *Coccystes* the antebrachium and manus are subequal and longer than the brachium.

The variation in the length of the wing among the Cuculi becomes still more forcibly illustrated when compared with the hind limb, the difference apparently varying with the power of flight.

In *Cuculus*, *Coccyzus*, and *Cacomantis*, for example, the wing is considerably longer than the leg. In *Chrysococcyx* the two limbs are subequal. In *Geococcyx*, *Crotophaga*, and *Coua* the wing is much shorter. Taking the combined length of the femur and tibio-tarsus of each species as a standard of measurement, it will be found that in *Crotophaga* the wing exceeds this length only by the distance from the middle of Ph. I. D. II. to the tip of the wing. In *Geococcyx* the wing is slightly less than the length of the standard. *Coua* has the shortest wing of all, it being about $\frac{1}{5}$ shorter than the combined length of femur and tibio-tarsus.

In the Musophagi the brachium is somewhat longer than the antebrachium, but the latter is considerably longer than the manus. The ulna, as in the Cuculi, bears prominent bosses for the attachment of remiges.

As in the Cuculi, the *collum trochleæ* is very conspicuous, giving the distal end of the humerus an obliquely truncated form. The coraco-humeral groove is wanting. The proximal border of the *crista superior* is very long and concave, the distal border short and convex. The ectepicondylar tubercle is very small.

The Ph. of D. III. in the Cuculi sends outwards from its post-axial border a prominent spur, this is wanting in the Musophagi.

ix. The Pelvic Limb.

The pelvic limb in the Cuculiformes has, in common with the Psittaci and many Coraciiformes, a zygodactyle pes. The hypotarsus is complex, and the tibio-tarsus has an ossified extensor bridge. In all save *Geococcyx* the limb is non-pneumatic, and in this genus only the femur is pneumatic.

The pelvic limb of the Cuculiformes has the 2nd and 3rd trochleæ nearly equal in length, but the latter is conspicuously larger in size. The third trochlea is placed comparatively high

up the shaft, and has the glenoid articular surface conspicuously laterally compressed and twisted, so as to cross the long axis of the shaft transversely. This limb may be readily distinguished from that of the Psittaci, inasmuch as in the latter the trochlea of D. II. stands out at right angles to the tarso-metatarsal shaft, whilst the trochlea for D. IV. has rotated so that its articular surface is turned to look directly backwards. Thus, the outer condyle comes to lie next the shaft, and, furthermore, is produced into a hook-shaped process of considerable size.

Amongst the Coraciiformes, probably the pelvic limb of *Leptosoma* most nearly resembles that of the Cuculiformes, but the conspicuously higher position on the shaft of the trochlea of D. IV., which obtains in this last group, is sufficient to prevent confusion.

The fibular ridge is confined to the upper end of the shaft, and increases in depth from above downwards.

The length of the fibula may vary considerably even in different species of the same genus. Usually it is greatly reduced, but in *Centropus toulou*, for example, it extends considerably beyond the middle of the tibial shaft, whilst in *C. madagascariensis* it falls considerably short of this.

In *Crotophaga*, *Eudynamys*, and *Rhopodytes* it barely extends beyond the level of the tibial fibular ridge.

The cnemial crests are, as a rule, feebly developed, indeed only in *Geococcyx* do they attain to any respectable size. In this species the entocnemial crest is more or less quadrate in form; its outer border is convex, its inferior concave. The ectocnemial crest is triangular in form, and terminates in a small pointed process immediately in front of the head of the fibula.

The shaft of the tibia is long, slender, and cylindrical, and bowed slightly forwards. In *Geococcyx* the posterior lateral borders of the internal mesotarsal condyle are produced backwards and upwards to form a rather prominent spur.

The popliteal fossa of the femur is obsolete.

The pelvic limb of the Musophagi is less specialised in some respects than that of the Cuculi. This is especially marked in the character of the tarso-metatarsus. As in the Cuckoos, the hypotarsus is complex, and the tarso-metatarsal shaft grooved in front; but the arrangement of the distal trochleæ is of a less specialised character, and this fact is especially marked in *Schizorhis*, the foot of which in this respect closely resembles that of *Leptosoma*. The foot of *Schizorhis*, however, may readily be distinguished from that of *Leptosoma* inasmuch as in the latter the trochlea for D. IV. bears a very strongly-developed outer lip, which is produced inwards towards Mc. I. In *Schizorhis* this trochlea is almost indistinguishable from that of an ordinary eleutherodactyle foot. In *Turacus*, however, the form of the outer trochlea nearly resembles that of the Cuculi, but is less markedly compressed, and looks backwards and slightly inwards, instead of being twisted so as to cross the shaft transversely. Moreover, it is not raised high up on the shaft as in the Cuckoos.

x. Summary.

The isolated position of the Cuculiformes among the Coraciomorphæ is as evident from a study of the osteology of the group as from other points of view. Their nearest allies, judged from an osteological standpoint, would appear to be the Coraciidæ (*Coraciinæ* and *Leptosomatinæ*) and Bucconidæ on the one hand, and—more remotely—the Opisthocomi on the other. Their relationship to the Psittaci, which is generally agreed upon, would, I think, never be suspected from a comparison of the skeletal framework. This fact is probably to be explained by the great amount of specialisation which the Parrots have undergone.

Concerning the association of the Cuculiformes with the Bucconidæ, a few words of explanation are necessary. Although this connection has several times been made by the older ornithologists, Fürbringer appears to be the only modern systematist who, on anatomical grounds, takes a similar view. Gadow (**3**) regards the Bucconidæ as close allies of the Galbulidæ, placing the two in the same family—Galbulidæ. Beddard, on the other hand, widely separates these two forms, and I think rightly so. He places the Bucconidæ between the Pici and the Rhamphastidæ, but remarks that this is a family which "is at present little known, and whose affinities are therefore doubtful. It is only provisionally that I place them in the present position."

The claims to relationship, of the group now under consideration, to the Opisthocomi are, on osteological grounds, not at first sight very strong. A careful study, however, of the skulls of Cuculi and Musophagi, and a comparison with *Opisthocomus*, will show points of agreement which suggest affinity rather than convergence. The Musophagi most nearly approach *Opisthocomus*. The pelvis and sternum of *Opisthocomus* are Cuculine.

That the Cuculidæ and Musophagidæ are very near allies there can be no doubt. Indeed, the relationship between these two is the only relationship about which we can speak with any real certainty.

According to the British Museum Catalogue of Birds, vol. xix., the Cuculidæ (suborder Cuculi) embraces 47 genera and includes 202 species grouped under 6 subfamilies. This scheme is the work of Capt. Shelley. Beddard (**1**) recognises only 3 subfamilies, and these, I think, will be found to meet all demands. Further, it is quite open to question whether even these should not be regarded as groups *a*, *b*, *c*, rather than subfamilies.

Osteologically, the Cuckoos vary far more widely in respect of the pelvis and sternum than in any other character. The great feature in the skull is the uniform plan of the palate. Trusting to this alone, one might divide the Cuckoos into two groups—*Coua* in the one, and all the rest of the Cuckoos in the other: yet the difference in the two palates is trivial. The only other characters offered the systematist to choose from are the form of the lachrymal and temporal fossæ and the shape of the beak,

but the latter at any rate is the direct outcome of adaptation. Probably the remarkably specialised condition of the pelvis also is adaptive.

In the accompanying table it will be found that I have arranged the Cuckoos on a plan formed of a compromise between that of Beddard, based on the pterylography and voice-muscles, and one based on the osteology and voice-muscles. The two will be found to disagree in many points; and it is on this account that I have published the results of my comparison, since it will, I hope, stimulate further research by directing renewed attention to the anatomy of the discordant forms.

A. Sternum with single pair of notches; pectineal process of pelvis vestigial. Muscle-formula AXY+, except *Eudynamys* which has the formula ABXY+.

a. Syrinx tracheo-bronchial. Muscle-formula AXY+, except *Eudynamys* which has ABXY+. Old World.	*Cuculus.* *Coccystes.* *Coccygus.* *Eudynamys.* *Scythrops.*
b. Syrinx bronchial. Muscle-formula ABXY+. New World.	*Crotophaga.* *Guira.*

B. Sternum with single pair of notches; pectineal process of pelvis large.

c. Syrinx bronchial. Muscle-formula ABXY+. Old World.	*Centropus.* *Dromococcyx.*

C. Sternum with two pairs of notches; pectineal process large.

d. Syrinx bronchial. Muscle-formula ABXY+.	
New World	*Geococcyx.*
Old World	*Coua.*
e. Syrinx tracheo-bronchial. Muscle-formula ABXY+, except *Piaya* which has AXY+. Old World.	*Rhinococcyx.* *Rhamphococcyx.* *Urococcyx.* *Rhopodytes.* *Zanclostomus.* *Taccocoua.* *Piaya.* (New World.)

D. Sternum with two pairs of notches; pectineal process vestigial.

f. Syrinx tracheo-bronchial. Muscle-formula AXY+. Old World.	*Chrysococcyx.* *Cacomantis.*

Mr. Beddard has shown, in tabular form, the points wherein the skulls of the Cuculi and Musophagi differ one from another. These are not many, and I cannot but think that they are really of slight importance. The most striking are the differences in the size of the antorbital plate, the position of the maxillary end of the quadrato-jugal bar relatively to the tomium, and the relation of the mesial borders of the proximal ends of the palatines. The desmognathism of the palate seems to me to be precisely similar in both forms. If the skull of *Turacus*, for example, be compared with that of *Coua*, it will be found that the chief difference lies in the more spongy nasal septum of the latter,

which descends so as to lie between and force apart the maxillo-palatine, causing the palate to be *indirectly* desmognathous. In *Turacus* the nasal septum fuses with the dorsal borders of the maxillo-palatine, and does not descend between them, but in this case also the palate is indirectly desmognathous. In both *Coua* and *Turacus*, but for the septum, the palate would be schizognathous. But the maxillo-palatine region in *Schizorhis*, for example, is practically identical with that of normal Cuculi. *Coua* has the least specialised palate among the Cuculi; *Turacus* among the Musophagi. In the more specialised skull of both groups indirect desmognathism appears to have taken place by the descent of the ventral border of the septum nasi between the maxillo-palatine processes; resulting in the formation of a flat palatal surface, or one with a slight median groove.

The very striking differences in the form of the pelvic girdle stand in strong contrast with the uniformity found in the skull. How considerable these differences in the girdle are may be seen in the figures on pp. 277, 280, and 282.

Finally, I may remark that a great deal yet remains to be done before our knowledge of the Osteology of this group is complete. Of the nestling skeleton of the Musophagi we know nothing, and only a very little concerning the early stages of the Cuculi.

Only about one-third of the total number of genera of Cuculi are represented in the Museum Collection of skeletons. These, however, fortunately, include all the more important forms.

xi. Key to the Osteology of the Cuculiformes.

A. Skull.

Palate desmognathous, and without conspicuous anterior palatal vacuity; nostrils holorhinal, imperforate; basipterygoid processes wanting; vomer vestigial or wanting; pterygoid free; lachrymal free; antorbital plate large; the postorbital process never extending down to the quadrato-jugal bar.

A. Mesial border of palatines not meeting in middle line, leaving parasphenoidal rostrum exposed; with a large os uncinatum ..... Musophagi.

B. Mesial border of palatines meeting in middle line below and concealing parasphenoidal rostrum ..... Cuculi.

Key to the Genera of Cuculidæ.

a. Beak long and pointed.
  a'. Lachrymal with massive descending process; nostrils linear near the middle of the tomium; temporal fossæ confined to lateral aspect of skull. *Geococcyx.*
  b'. Lachrymal very small; temporal fossæ meeting one another to form a broad sagittal crest ..... *Saurothera.*
b. Beak with a high median keel; lachrymal large ..... *Crotophaga.*
c. Beak swollen, with an arched culmen.
  c'. Palatines fused in median line posteriorly ..... *Scythrops.*
  d'. Palatines free posteriorly.
    a''. Nostrils linear immediately above tomium; postorbital process of lachrymal large..... *Rhamphococcyx.*
    b''. Nostrils oval immediately above base of tomium, and bounded above or confluent with a conspicuous fenestra; postorbital process of lachrymal small ..... *Rhinococcyx.*

d. Beak not exceeding the cranium in length, of medium size, and with a more or less strongly arched culmen.

e'. Descending process of lachrymal vestigial or wanting; temporal fossæ meeting to form a sagittal crest; nostrils more or less markedly reni form, being formed like those of *Rhinococcyx* by the confluence of the narial aperture with a superior fenestra.

e''. Descending process of lachrymal in form of delicate incurved style.

a'''. Sagittal crest reduced to a mere line ..... *Rhopodytes*.

b'''. Sagittal crest broad ..... *Zanclostomus*.

d''. Descending process of lachrymal reduced to a stump. *Piaya*.

e''. Descending process of lachrymal wanting; antorbital plate slightly inflated ..... *Taccocua*.

f'. Descending process of lachrymal moderately strong, bent outwards and backwards upon the supraorbital portion; temporal fossæ meeting to form a broad sagittal crest.

f''. Horizontal process of lachrymal longer than descending; pterygoid with dorsal keel; interorbital fenestra large ..... *Guira*.

g''. Horizontal process of lachrymal not exceeding descending process, and having free orbital border sharply truncated; interorbital fenestra small. *Eudynamys*.

g'. Descending process of lachrymal slender; temporal fossæ meeting to form a broad sagittal crest; interorbital fenestra very large ... *Centropus*.

h'. Temporal fossæ confined to lateral aspect of skull.

h''. Lachrymal moderately large and not distinctly divided into supraorbital and descending processes; antorbital plate spongy; interorbital fenestra large; maxillo-palatines not meeting in middle line, but palate edged by nasal septum ..... *Coua*.

i''. Lachrymal moderately large, with slender descending process; nostrils cricular, just above base of tomium ..... *Coccystes*.

j''. Lachrymal vestigial; mandible with broad flange at gape.

c'''. Temporal fossæ present ..... *Cuculus*.

d'''. Temporal fossæ obsolete ..... *Cacomantis*.

B. Vertebræ[1].

All the presynsacral vertebræ are free and heterocœlous; neural arch of atlas broad; hypapophyses blade-shaped, not extending beyond 2nd thoracic vertebra. Axis vertebra not conspicuously shortened antero-posteriorly, and not having conspicuously upturned hyperapophyses.

A. Lateral borders of thoracic vertebræ terminating in a sharp backwardly directed spike ..... Musophagi.

B. Lateral borders of thoracic vertebræ not produced into spikes. Cuculi.

C. Pectoral Girdle and Sternum.

Coracoid with a well-developed procoracoid; clefts of the posterior notches of sternum never extending as far forwards as the level of the articulation of the ribs; furcula large.

A. Procoracoid fused with acrocoracoid; furcula with a well-marked facet for articulation with the fused pro- and acrocoracoids; anterior border of carina sterni continued forwards to level of spina externa ..... Musophagi.

B. Procoracoid not fused with acrocoracoid; furcula without articular facet for acrocoracoid; anterior border of carina sterna not continued forwards as far as free end of spina externa ..... Cuculi.

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[1] The presynsacral vertebræ of the Cuculiformes are scarcely to be distinguished from those of the *Coraciinæ* and *Leptosominæ*.

Key to the Genera of Cuculidæ.

a. Sternal plate with spina communis.
  a'. Posterior border with two pairs of notches.
    a''. Hypocleideum styliform, free end only overlapped by carina sterni. *Rhamphococcyx.*
    b''. Hypocleideum styliform, overlapped by carina sterni. { *Rhinococcyx.* / *Coua.* }
    c''. Hypocleideum oval, overlapped by carina sterni ..... { *Rhopodytes.* / *Piaya.* }
  b'. Posterior border with single pair of notches ..... *Coccystes.*
b. Sternal plate with spina externa only.
  c'. Posterior border of sternal plate with two pairs of notches.
    d''. Hypocleideum underlapped by carina sterni ..... *Zanclostomus.*
    e''. Hypocleideum with free end only underlapped by carina. *Geococcyx.*
  d'. Posterior border of sternum with a single pair of notches.
    f''. Hypocleideum obsolete; procoracoid small, affording articulation for scapula.
      a'''. Furcula large and strongly arched ..... *Scythrops.*
      b'''. Furcula slender and slightly arched.
        a^4. Posterior lateral process broad ..... *Eudynamys.*
        b^4. Posterior lateral process narrow ..... *Guira.*
    g''. Hypocleideum obsolete; procoracoid large, not affording articulation for scapula..... *Centropus.*
c. Sternal plate with spina interna only ..... *Taccocoua.*
d. Sternal plate without spines ..... { *Crotophaga.* / *Dromococcyx.* }
e. Sternal plate with spina externa and interna distinct.
  h''. Posterior border of sternum with a single pair of notches. *Cuculus.*
  i''. Posterior border of sternum with two pairs of notches. *Chrysococcyx.*

D. Pelvic Girdle.

A. Preacetabular ilium with strongly arched border meeting in the median line above the synsacral spines to form a large *canalis ilio-lumbalis*... Musophagi.

B. Preacetabular ilia with dorsal border never meeting in median line above synsacral spine ..... Cuculi.

Key to the Genera of Cuculidæ.

a. Presynsacral neural arches broad and without neural spines; ilia widely separated.
  a'. With large intertransverse sacral foramina..... { *Cacomantis.* / *Cuculus.* }
  b'. No intertransverse sacral foramina.
    a''. Length not exceeding 1 inch ..... *Chrysococcyx.*
    b''. Length not less than $2\frac{1}{2}$ inches ..... *Scythrops.*
b. Presynsacral neural arches bearing a high median ridge; no intertransverse sacral foramina.
  c'. Pectineal process vestigial.
    c''. Antero-dorsal angles of pre-ilium not meeting in mid-dorsal line; pubis very long..... *Eudynamys.*
    d''. Antero-dorsal angles of pre-ilium meeting in middle line; pubis short ..... { *Crotophaga.* / *Guira.* }
  d'. Pectineal process large.
    e'. Ischio-pubic fissure slit-shaped and very narrow.
      a'''. Antero-dorsal angles of pre-ilium produced into narrow bars meeting in middle line ..... { *Centropus.* / *Dromococcyx.* }
      b'''. Antero-dorsal angle of pre-ilia produced inwards to form a quadrate plate embracing neural spines; postacetabular ilia produced into an enormous saddle-shaped plate ..... *Geococcyx.*
    f''. Ischio-pubic fissure extremely reduced.
      c'''. Antero-dorsal angle of pre-ilia produced into a quadrate plate with concave superior border just reaching neural spine ... *Taccocoua.*
      d'''. Antero-dorsal angle of ilia produced into rounded angles, not reaching the neural spines ..... { *Rhinococcyx.* / *Rhopodytes.* }
      e'''. Ischio-pubic fissure very wide, closed posteriorly... *Rhamphococcyx.*

References.

(1) Beddard, F. E.—Classification of Birds. 1898.
(2) Fürbringer, M.—Vergleich. Anat. d. Brustschulterapparates. Theil v.: Vögel. 1902.
(3) Gadow, H.—Bronn's Thier-Reich. Bd. vi. Vögel. Syst. Theil. 1893.
(4) Parker, W. K.—Trans. Linn. Soc., 2nd ser. Zool. vol. i., 1879.

xii. EXPLANATION OF PLATE XXII.

Fig. 1. Ventral aspect of the skull of *Coua reynaudi*, showing the most primitive form of the indirectly desmognathus skull of the Cuculidæ. Herein the maxillo-palatines do not meet in the middle line, but the palate is bridged by the swollen nasal septum. Basipterygoid processes are wanting. There is no vomer.

Fig. 2. Ventral aspect of the skull of *Turacus buffoni*, showing the indirectly desmognathous type of palate of the Musophagidæ. The maxillo-palatines do not meet in the middle line, but the palate is bridged by the fusion of the ventral border of the nasal septum with the dorsal aspect of the maxillo-palatines. The vomer is wanting, but present in a vestigial condition in *Schizorhis*. Note the appearance of the parasphenoid between the palatines.

Fig. 3. Dorsal aspect of the skull of *Coua reynaudi*, showing the absence of a nasal hinge, and the general character of the roof of the skull.

Fig. 4. Dorsal aspect of the skull of *Turacus leucotis*, showing the nasal hinge and the general conformation of the roof of the skull.

Fig. 5. Dorsal aspect of the skull of *Saurothera vetula*, showing the long upper jaw and the large temporal fossæ.

Fig. 6. Lateral aspect of the skull of *Schizorhis zonura*, showing the form of the narial apertures, the *os uncinatum* and the general form of the skull.

Fig. 7. Lateral aspect of the skull of *Rhinococcyx calorhynchus*, to show the form of the narial aperture and the general form of the cranium.

Fig. 8. Lateral aspect of the skull of a nestling *Centropus*, showing the arrangement of the bones. Outer view.

Fig. 9. Lateral aspect of the inner view of the same skull, showing the separate arrangement of the bones.

Fig. 10. The distal end of the pterygoid of the nestling *Centropus*, to show the hemipterygoid.

Explanation of Letters.

als.=alisphenoid.
a.p.=antorbital plate.
a.p.v.=anterior palatine vacuity.
b.oc.=basioccipital.
b.s.=basisphenoid.
c.=occipital condyle.
ep.o.=epiotic.
ex.o.=exoccipital.
f.f.=floccular fossa.
fr.=frontal.
h.pt.=hemipterygoid.
l.=lachrymal.
mc.=meatus internus.
mes.=mesethmoid.
na.=nasal.
n.h.=nasal hinge.
op.=opisthotic.
o.u.=os uncinatum.
p.=parietal.
p.a.=palatine.
par.=parasphenoidal rostrum.
p.o.p.=postorbital process.
pro.=prootic.
pt.=pterygoid.
q.=quadrate.
s.c.=sagittal crest.
s.o.=supraoccipital.
sq.=squamosal.
t.f.=temporal fossa.

April 21, 1903.

Dr. Henry Woodward, F.R.S., Vice-President, in the Chair.

The Secretary read the following report on the additions made to the Society's Menagerie in March 1903:—

The registered additions to the Society's Menagerie during the month of March were 67 in number. Of these 14 were acquired by presentation, 43 were received on deposit, and 10 in exchange. The total number of departures during the same period, by death and removals, was 89.

The following papers were read:—

1. Linnæus and Hunter on Feather-Tracts.

By Henry Scherren, F.Z.S.

[Received March 12, 1903.]

(Text-figure 49.)

The credit of using the feather-tracts of birds as a means of classification belongs undoubtedly to Nitzsch, whose results, edited after his death, by Burmeister, were published at Halle in 1840 under the title 'Pterylographie'. An English edition, translated by W. S. Dallas and edited by Dr. Sclater, was brought out by the Ray Society in 1867. Pterylosis, or the distribution of these feather-tracts, is, according to Prof. Newton, "of prime taxonomic importance in Ornithology, though more in the investigation of small than of large groups." This also seems to have been the opinion of Nitzsch himself, who, however, was not aware that anything at all had been done even in noting the existence of such tracts and of the featherless spaces which he called *apteria*. In his Introduction he says:—

> I may, therefore, flatter myself with the hope of awakening the interest of naturalists by the announcement of my new results, and, by the enumeration and detailed description of the feathered regions of the bodies of birds to which I give the name of feather-tracts (*pterylæ, Federnfluren*), of proving that these, new and surprising as they may appear to many on the first glance at my figures, really furnish equally significant and important characters for the certain and natural discrimination of the families of birds.

Professor Newton ('Dict. Birds,' Introd. p. 63, note 1) says that the only men before Nitzsch's time who seem to have noticed feather-tracts were the great John Hunter and the accurate

Macartney. The observations of the latter were published in 1819 (Rees's Cyclopædia, article Feathers) :—

> Although the common feathers cover the whole body, they do not grow from every part of the skin; they are thickest upon the shoulders and loins, along the underpart of the neck and breast, and do not exist upon the lateral lines of the neck or breast, or about the umbilicus. This arrangement, and their being directed downwards and backwards, allows them to cover the body more neatly, and to remain unruffled during the motions of the bird.

The observations of Hunter appeared first in Owen's 'Catalogue of the College of Surgeons' (vol. iii. pt. ii. p. 311), dated 1836 :—

> Although the feathers of birds appear to be an entire and uniform covering, they do not arise equally from every part of the body, but only from such parts of the skin as are least liable to be affected by the motion of the contiguous parts, such as the motion of the limbs.

Hunter, however, seems to have done something more, and to have discriminated the feather-tracts, for, on the page quoted above, we read :—

> To these groups or thickets of feathers I shall give particular names, taken from their situation.

It is, of course, only a coincidence that Hunter used the terms "thickets of feathers," and that Nitzsch, in his Essay, 'Pterylographiæ Avium, Pars prior,' 1833, chose a very similar name, *pterylæ*, which Prof. Newton has translated "feather-forests." It may perhaps be of service to record the fact.

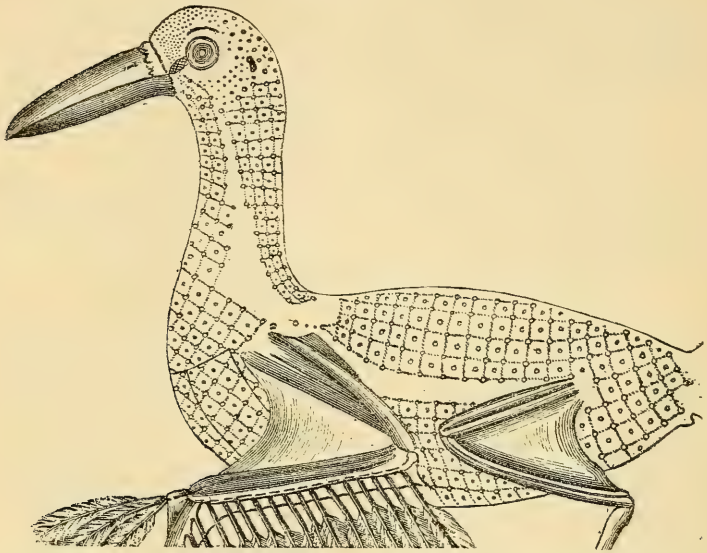
If the date of Hunter's observations be taken at about 1785, in which year he built his Museum, an earlier notice of the feather-tracts exists by at least twenty years. This occurs in the treatise by Linnæus, 'Fundamenta Ornithologica,' presented at Upsala by A. P. Bæckmann, May 4, 1765 (Amœnitates Acad. vii.). Premising that the feathers are arranged in the form of a quincunx, the author proceeds :—

> Nuda vero cutis est (h. e. pennarum *quincunce* non perforata aut tecta) utrinque ad colli latera, a capite interscapulium versus, et ab axillis per latera pectoris ad inguina usque, atque per femora postica, remotis integumentis, videnda.

This is as clear as language can make it. If, however, any doubt could exist, this would be at once removed by reference to the plate (see text-fig. 49, p. 294), where, in a schematic bird, the contour-feathers are arranged in quincunces, and there the bare space running from the neck to the femur is connected with that on the opposite side by the naked patch in the interscapular region. The naked spaces, as figured, would, if looked at from above, form a quincunx; and the text recalls a passage in the 'Garden of Cyrus,' where Browne writes of the quincuncial arrangement in the "feathery plantation about birds." Although the primary reference by Browne is to the papillæ in the feather-tracts, I suggest (and in this I am glad to have the support of Mr. Southwell)

that the passage alluded to shows that Sir Thomas Browne was fully aware of the distribution of the feathers in well-defined regions, and that these differed in position and extent in different birds. Moreover, I believe the passage in the 'Amœnitates' shows that Linnæus knew of Browne's work. Besides the reference to the quincunx already quoted, there is yet another—"Pennæ quæ

Text-fig. 49.



Topographical diagram showing feather-tracts and bare spaces in schematic bird.
(Reduced from 'Amœnitates Academicæ,' vii. tab. i. fig. A.)

(præter alas et caudam) reliquum corpus servant, in *quincuncem* digestæ sunt"; and his phrase "mirando nunquam satis artificio, quod in Colymbi præsertim corio, alutariorum arte præparato . . . est conspicuum," is strangely reminiscent of the note of the famous Norfolk naturalist: "Elegantly conspicuous on the inside of the stripped skins of the dive-fowl."

2. On some Mammals collected by Capt. H. N. Dunn, R.A.M.C., in the Soudan. By Oldfield Thomas, F.R.S.

[Received March 11, 1903.]

The National Museum owes to Capt. H. N. Dunn a collection of Mammals, mostly small, made by him in the Egyptian Soudan in the course of 1902. Among these no less than five prove to need new names, thus showing how much still remains to be done

in studying the mammals of this interesting region; and it is hoped that other officers will follow Capt. Dunn's example.

The localities at which collections were made are mostly rather to the southward of Khartoum, the majority of them being in Kordofan, a province hitherto almost entirely unrepresented in our collections.

Besides the earlier writings of Sundevall [1] and Heuglin [2] on the Mammals of this region, reference may be made to a paper by Mr. de Winton on a collection from Shendy [3], to the north of Khartoum, to the same author's work [4] in conjunction with the late Dr. J. Anderson on the Mammals of Egypt generally, and to a small paper [5] of my own on Mr. Hawker's collection from the Fashoda region of the Nile.

1. Rousettus stramineus Geoff.

4. ♂. Khartoum. 15 August, 1902.

2. Hipposiderus caffer Sund.

65. ♂. El Obeid, Kordofan. 22 October, 1902.

H. caffer had already been recorded from this region by Temminck [6].

3. Megaderma frons Geoff.

9. Wad Medina, Blue Nile. 21 September, 1902.

4. Taphozous perforatus Geoff.

1, 2, 3. ♂ ♀ ♀. Khartoum. 28 June, 1902.

5. Canis anthus soudanicus, subsp. n.

60. ♀. El Obeid. 2 October, 1902. (B.M. No. 3.2.8.8.) *Type.*

119. Habessa Wells, W. Kordofan. 7 December, 1902.

The eastern representative of the Senegal *C. anthus* F. Cuv. Closely allied to the typical form, but paler and with markedly smaller teeth.

General characters as in true *C. anthus*. Colour rather paler, a clear sandy buff. Hairs of back and of tail broadly tipped with black. Skull, as may be gathered from the measurements below, smaller and more delicate.

Dimensions of the type:—

Head and body 650 mm.; tail 230; hind foot (s. u.) 137; ear 80.

Skull: basal length 136; zygomatic breadth 78; length of

[1] "Om Professor J. Hedenborgs insamlingar af Däggdjur i Nordöstra Africa," K. Vet.-Ak. Handl. 1842, p. 189.
[2] Reise N.O.-Afrika, ii., 1877.
[3] Nov. Zool. viii. p. 397 (1901).
[4] Anderson & de Winton, 'Mamm. Egypt,' 1902.
[5] Ann. Mag. N. H. (7) viii. p. 273 (1901).
[6] *Fide* Anderson, 'Mamm. Egypt,' p. 102.

nasals (diagonally) 49; interorbital breadth 26; breadth across postorbital processes 37; breadth of brain-case 49·5; palate, length 72·5; breadth between outer corners of p.^{4} 44.

Teeth: length of p.^{3} 9·6, of p.^{4} (on outer edge) 14·2, of m.^{1} 11, of m.^{1} and m.^{2} combined 16·8; breadth of m.^{1} 14, of m.^{2} 10. (Below), length p.$_3$ 8·7, of p.$_4$ 10, of m.$_1$ 17·3, m.$_2$ 8·1.

Hab. and *type* as given above.

This is the Jackal figured by Cretzschmar [1] from Rüppell's specimen as *C. anthus*, but is clearly at least subspecifically different from that animal. Mr. de Winton has recently shown [2] that none of the earlier names of Hemprich and Ehrenberg or other authors apply to this form, and I therefore venture to bestow one on it.

6. Vulpes vulpes ægyptiaca Sonn.

40. ♀. Khartoum. 4 September, 1902.

7. Vulpes pallida Cretzschm.

8. ♂ (young). Wad Medina, Blue Nile. 18 September, 1902.

8. Ictonyx frenata Sund.

118. ♂. Gebel Haraza, W. Kordofan. 6 December, 1902.

The rediscovery of this species is of interest, as there has always been some doubt whether it was or was not the same as the more northern *I. lybica*. It proves to be readily distinguishable by its smaller size, by certain differences in its body pattern, and, especially, by the absence of the black ends to the caudal hairs.

9. Dipodillus stigmonyx Heugl.

5. ♀. Khartoum. 19 August, 1902.

A topotype of the species. As already noted [3], the specimen in the Stuttgart Museum marked *Meriones stigmonyx* does not agree with Heuglin's description of this animal, and is more like that of his *M. dongolanus*.

It is to be observed that the present Gerbille and the next one are so extremely alike, that it is almost impossible to distinguish them apart except by an examination of the soles and skulls. There is, however, a darker median area ("Scheitel und Rückenmitte satter gefärbt") in the *Dipodillus* not present in the *Gerbillus*, and this confirms my previous allocation of the name, which in any case having once been made should be adhered to.

10. Gerbillus agag, sp. n.

96. ♂. Agageh Wells, W. Kordofan. 17 November, 1902. (B.M. No. 3.2.8.11.) *Type.*

A small species of true hairy-footed *Gerbillus*, with comparatively short tail.

[1] Atl. Rüpp. Reise Mamm. pl. 17 (1826).
[2] Anderson & de Winton, Mamm. Egypt, p. 213 (1902).
[3] Ann. Mag. N. H. (7) viii. p. 276 (1901).

Size small, and feet short. General colour above soft sandy buff, slightly lined on the back with the dark tips to the hairs, but without any marked darker dorsal area. Along the back the bases of the hairs are plumbeous, but laterally, still within the sandy area, the hairs are broadly ringed with white subterminally, though this colour does not show on the surface. Under surface pure sharply defined white as usual. Cheeks, a prominent patch above and behind each eye, and another behind the ear white. Whole of fore limb white, hind limb with a sandy line down its outer side, the inner side and whole of feet snowy white; palms and soles thickly hairy. Tail short for this group, pale sandy above, darkening towards the pencilled end; white below.

Skull unfortunately broken in the single specimen. Molars markedly smaller and lighter than in the common Soudanese *G. pygargus*.

Dimensions of the type:—

Head and body 87 mm.; tail 100; hind foot (s. u.) 24; ear 11. Length of upper molar series 3·7.

Hab. and *type* as given above.

This little Gerbille is distinguished from its neighbour *G. pygargus* by its smaller size and shorter tail. Its close resemblance to *Dipodillus stigmonyx* has already been noted.

11. Arvicanthis dunni, sp. n.

103. ♂. Kaga Hills, W. Kordofan (about 120 miles W. of El Obeid). 20 November, 1902.

"Dug out of reddish sandy cultivation soil, from among the natives' crops of dukhan."—*H. N. D.*

A many-striped species of the *A. barbarus* group; allied to *A. zebra*, but smaller, paler, and with the light and dark stripes less contrasted.

Size small, the smallest of the group. General pale ground-colour buff, the lateral darker stripes brown instead of black. Head coarsely grizzled buffy and brown. Central dorsal stripe beginning on the crown, very narrow, blackish, but not so deep a black as in *A. zebra*; outside this there are on each side five uninterrupted buffy stripes, separated from each other by broad brown bands, each of which is divided down the centre into two by an interrupted band of light, an arrangement essentially as in the other species. The light spaces are throughout clear buff, and the dark lines brown, a clear buffy line passing along below the outermost dark line and edging the pure white of the belly. In *A. zebra* the outer lines at least are white, only those near the spine being buffy. Eye-ring buffy. Ears dull ochraceous, without darker marking. Arms and legs pale buffy, becoming white on the fingers and toes. Tail well-haired; dull ochraceous above, with a narrow and inconspicuous mesial line of black; whitish below.

Skull conspicuously smaller than in *A. zebra* and the other species of the group, with rather larger bullæ; incisors narrower, but molars rather larger in proportion.

Dimensions of the type :—

Head and body 90 mm. ; tail 70 ; hind foot (s. u.) 23 ; ear 14.

Skull—greatest length 28 ; basilar length 22 ; zygomatic breadth 13 ; nasals 10 × 3·4 ; interorbital breadth 4·4 ; breadth of brain-case 12 ; palate, length 12·2 ; diastema 6·7 ; palatal foramina 5·6 ; length of upper molar series 4·9.

Type. Old male. B.M. No. 3.2.8.15. One specimen only.

A Fashoda striped rat presented by Mr. R. M. Hawker in 1901 being identified as *Arvicanthis zebra*, the present species may be readily distinguished from it by its much smaller size and more buffy coloration.

Capt. Dunn tells me that this rat was very common in the cultivated fields of the natives, burrowing in their crops of dukhan. It is a very handsome and distinct species, and I have much pleasure in connecting his name with it.

12. Acomys witherbyi de Wint.

73. ♂. Katul Hills. 30 October.

13. Leggada tenella, sp. n.

7. Old ♀. Roseres, Blue Nile. 14 September, 1902. (B. M. No. 3.2.8.13.) *Type*.

" Found in burrows in cornfield ; had 7 young in the womb."—*H. N. D.*

A very small species of the *L. minutoides* group.

General colour of cheeks and sides a clear sandy or ochraceous buff, with a distinct darker median dorsal area, commencing as a narrow well-defined line on the nose, broadening on the crown, and extending, though less sharply defined, all down the back, and dying away on the rump. Under surface pure sharply defined white. No lighter markings round eyes. Ears small, evenly rounded, grey, their edges faintly whiter; a large and prominent white patch behind and below their posterior bases. Fore limbs wholly white; hind limbs with a narrow line of the body-colour continued down on the hinder side to the heel, otherwise white. Tail about as long as the body without the head, brown above, inconspicuously lighter below.

Skull smaller and narrower than in the Cape *L. minutoides*, with square and well-defined supraorbital edges. Palatal foramina ending level with the anterior fourth of m.[1]. Posterior palate elongated, its hinder edge about equidistant from the last molars and the front of the bullæ.

Dimensions of the type :—

Head and body 50 mm. ; tail 35 ; hind foot 11·5 ; ear 9.

Skull : greatest length 17·2 ; basilar length 14 ; zygomatic breadth 9 ; nasals, length 6·3 ; interorbital breadth 3 ; brain-case, breadth 7·5 ; palate, length 9·3 ; palatal foramina 4·0 ; diastema 5·0 ; length of upper molar series 3·0.

Hab. and *type* as given above.

This beautiful little species is readily characterised by its strong sandy colour, the marked dorsal darkening, and elongated palate.

14. Jaculus gordoni, sp. n.

85. ♀. Gebel Agageh, W. Kordofan. 12 November, 1902.

104. 105. ♂ ♂. Kaga Hills, W. Kordofan. 20 November, 1902.

106. ♂. Gebel um Durragh, W. Kordofan. 25 November, 1902.

Allied to *J. jaculus* Linn., but larger and differently coloured, and with longer ears.

Size rather greater and build stouter than in *J. jaculus*. General colour above, as compared to the yellowish "buff" of *J. jaculus*, darker, and nearly approaching to "vinaceous buff" of Ridgway. Laterally, the dark colour seems to pass rather sooner into the pure white of the under surface. White markings more extended than in *J. jaculus*, the cheek, supraorbital, and postauricular white patches all large. White hip-stripe large, weakened in colour by a faint buffy or brownish sprinkling. Fore limbs wholly white. Hinder aspect of thighs like back. Fine hairs of feet silvery white, the terminal half of the long digital hairs sandy. Tail of the usual pattern, its basal portion isabelline buffy above; black subterminal band rather over an inch in length; white tip $\frac{1}{2}$–$\frac{3}{4}$ in.; longest hairs at end of tail 16–17 mm. in length.

Skull shaped quite as in *J. jaculus*, but larger and heavier throughout.

Dimensions of the type, measured in the flesh:—

Head and body 120 mm.; tail 200; hind foot (s.u.) 63; ear 25.

Skull: greatest length in middle line 34; basilar length 27·5; zygomatic breadth 24; tympanic breadth 24·7; length of nasals on outer edge 12·5; interorbital breadth 12·8; interparietal 5·7 × 8·7; palate, length 17·3; palatal foramina 4·7; diastema 9·6; length of upper molar series 5·1.

Hab. (of type). Kaga Hills, W. Kordofan. Also occurring at Omdurman.

Type. Old male. B.M. No. 3.2.8.16. Original number 104.

This Jerboa, which I have named in memory of the famous General Gordon, differs decidedly from the ordinary Egyptian *J. jaculus* by its larger size and different colour. The Museum had previously received a specimen of it from Omdurman, collected by Mr. W. L. S. Loat, but as that was young and without skull, it could not be described.

The only other species which need be referred to is *Dipus microtis* Reichenow[1] from "Samar, in Nord-ostafrica." That was founded on a young specimen, but the description of its teeth shows that it was sufficiently adult not to be the young of the present form, than which it is very much smaller ("Lauflänge

[1] Zool. Anz. x. p. 369 (1887).

35 mm."), with shorter ears, and with the remarkable character (if not due to accident) of having no white at the end of its tail.

15. Lepus æthiopicus H. & E.

6. ♂. Shendy. 1 September, 1902.
92.93.94.97. ♂ ♂ ♀ ♀. Agageh, Kordofan. November 1902.
39. ♂. Wad Medina, Blue Nile.

16. Procavia ruficeps H. & E.

77. ♂. Kaga Hills, Kordofan. 2 November, 1902.
78.79.80.83.88. Agageh Hills. November.

17. Oryx algazel dammah Cretzschm.

♂. Kordofan.

Practically a topotype of the subspecies.

When the 'Book of Antelopes' was published, owing to the predilection of the senior author for "well-established" names, the term *leucoryx* was used for the species to which Lichtenstein erroneously transferred that name, while the true *leucoryx* of the Persian Gulf was called by Gray's name *beatrix*. To put matters more in accordance with modern ideas on nomenclature, the Scimitar Oryx should bear the name *algazel* Oken; but as that name was founded on Cuvier's figure of a Senegal specimen, and it is practically certain that the Eastern Soudanese form is at least subspecifically distinct from the Western, a second name is required, and this we find in the "*Antilope dammah*" of Rüppell and Cretzschmar. *A. dammah* was erroneously identified by Rüppell, and following him by Sclater and myself, with the Beisa, but by its locality ("die grossen Steppen von Haraza") is clearly shown to be the Scimitar Oryx. This is fortunate, as the name *dammah*, being earlier than *beisa*, would have had to be used in the latter's place had Rüppell's identification been correct, but now the Beisa is left with its familiar name unaltered.

Briefly put, the nomenclature is as follows:—

Scimitar Oryx.

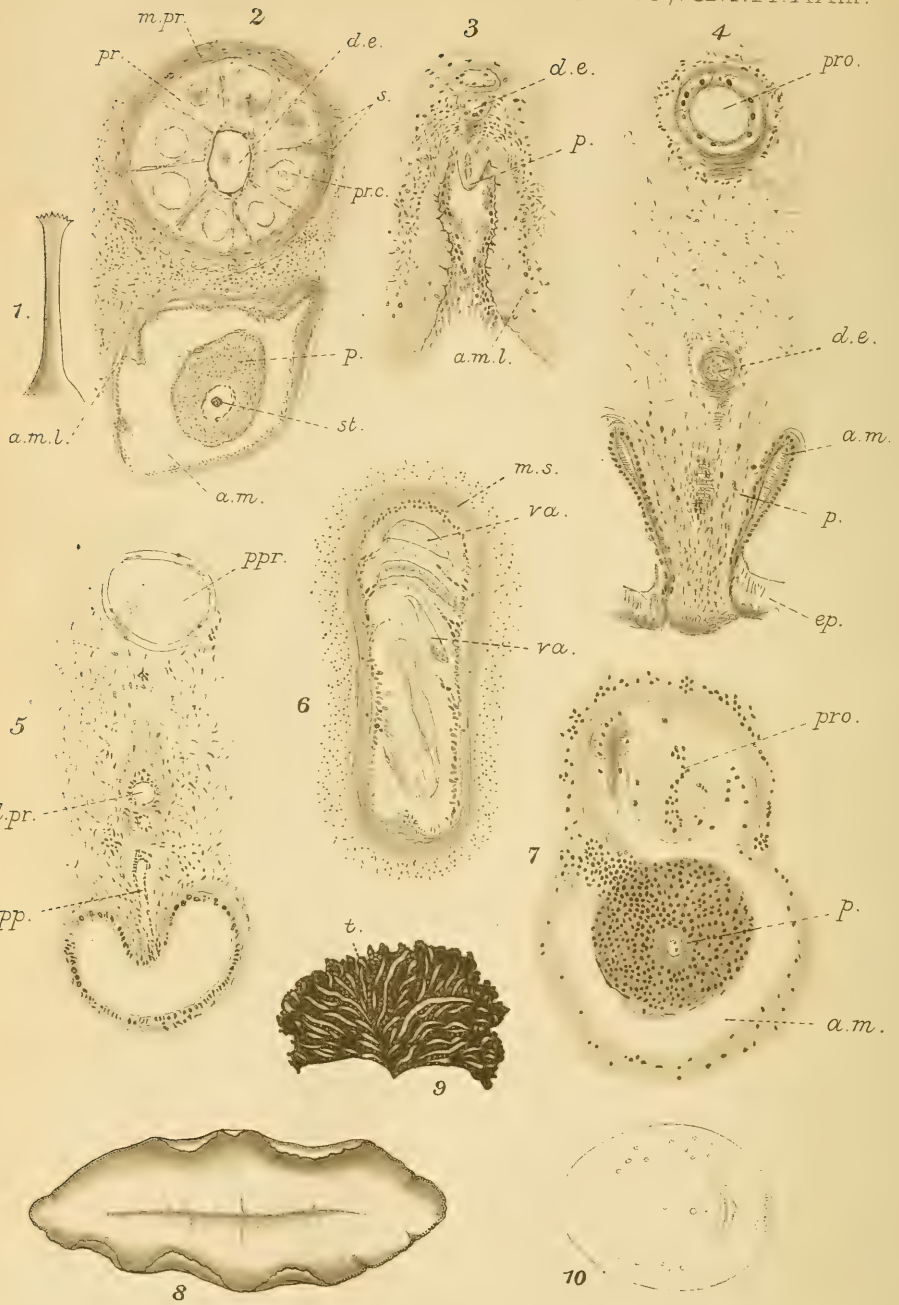
Oryx algazel Oken.
O. leucoryx of authors generally, not of Pallas.

Western form:—
Cemas algazel Oken, Lehrb. Nat. iii. pt. ii. p. 741 (1816); ex L'Algazelle, F. Cuv. H. N. Mamm. i. pl. 376 (1819). (Senegal.)

Eastern form:—
Antilope dammah Cretzschm. Atl. Rüpp. Reise, Mamm. p. 22 (footnote), 1826. (Haraza, Kordofan.)

White Oryx.

Oryx leucoryx Pall.
Antilope leucoryx Pall. Spic. Zool. xii. p. 17 (1777).
Oryx beatrix Gray, P. Z. S. 1857, p. 157, and of authors generally.



Bale & Danielsson Ltd lith.

POLYCLADS FROM THE STRAITS OF MALACCA.

18. Gazella ruficollis H. & E.

61. ♂. Gebel Tueis, 90 miles E. of Omdurman. 9 October, 1902.

This fine Gazelle is a most acceptable addition to the National Collection, in which the species is still badly represented.

19. Gazella rufifrons Gray.

♂ ♀. Agageh Wells, Kordofan. November 1902.

Capt. Dunn tells me that this Gazelle does not range beyond about 50 miles to the northward of El Obeid.

3. On a Collection of Turbellaria Polycladida from the Straits of Malacca. (Skeat Expedition, 1899–1900.) By F. F. Laidlaw, B.A. Cantab., Assistant Lecturer and Demonstrator in the Owens College.[1]

[Received March 19, 1903.]

[2] (Plate XXIII. & Text-figures 50–56.)

The collection described below was made entirely by Mr. Evans on the shores of a small islet called Pulau Bidan, a few miles north of Penang. It proves a most interesting one, and includes, so far as I can discover, only one previously known species, *Thysanozoon auropunctatum* Coll.

As in describing Mr. Gardiner's collection from the Maldives [4], I have to note the scarcity or absence of the Euryleptidæ, represented doubtfully only by a much damaged fragment in Mr. Evans's series.

The only previous record of species from the shores of the Malay Peninsula that I have been able to discover was made by Collingwood, who described and figured the following species from Singapore:—

Thysanozoon allmani.
Proceros hancockianus.
,, *buskii.*
Sphyngiceps lacteus.
Eurylepta kelaartii.
Elasmodes obtusum.
Leptoplana aurantiaca.

Grouping these specimens with those of the Skeat Collection and adding *Pseudoceros bedfordii* from Singapore, kindly given me by Mr. Lanchester, we get the following list classified according to Lang's system [6]:—

Acotylea.

Planoceridæ.

* *Planocera* sp.

1.* *Notoplana evansii*, sp. n.

[1] Communicated by Dr. S. F. Harmer, F.Z.S.

[2] For explanation of the Plate, see p. 318.

Acotylea (*con.*).

LEPTOPLANIDÆ.

2.* *Semonia penangensis*, sp. n.
3.* *Leptoplana malayana*, sp. n.
4. ,, *obtusum* (Coll.).

CRYPTOCELIDIDÆ.

5.* *Bergendalia anomala.*

LATOCESTIDÆ.

6.* *Latocestus argus.*

Cotylea.

PSEUDOCERIDÆ.

7. *Thysanozoon allmani.*
8.* ,, *auropunctatum.*
9. *Pseudoceros hancockianus* (Coll.).
10. ,, *buskii* (Coll.).
11. ,, *kelaartii* (Coll.).
12. ,, *bedfordii*, sp. n.
13.* ,, *collingwoodii*, sp. n.
14.* *Pseudoceros ? rubellus*, sp. n.

DIPOSTHIDÆ.

15.* *Asthenoceros woodworthi*, sp. n.

PROSTHIOSTOMIDÆ.

16.* *Prosthiostomum pallidum*, sp. n.
17. ,, *aurantiacum* (Coll.).

Species marked with an asterisk were collected by Mr. Evans.

In this communication I have not ventured to give an account of the anatomy of any of the species, contained in the collection, which can be regarded as being at all complete. Such an account would have expanded the paper beyond limits reasonable in a systematic description. I have attempted only to give such a diagnosis of each species as shall render its future identification a matter of tolerable certainty, and to call attention to any of the more striking features which presented themselves.

Family PLANOCERIDÆ.

PLANOCERA sp. (Plate XXIII. fig. 1.)

A fragment of tissue of which I made microscopic sections proves to belong to a species of this genus, but being only a fragment I will not attempt to describe or name it, though it is obviously new. The section passes through the penis and prostate, and the spines lining the lumen of the former are of such a remarkable character that I venture to figure one of them, in the hope that a perfect example may be obtained ere long. The length of each spine is roughly ·08 mm., its breadth at the base ·02 mm.

NOTOPLANA, gen. nov.

NOTOPLANA EVANSII, sp. n. (Plate XXIII. fig. 2.)

A number of specimens belonging to this species were taken by

Mr. Evans on the shores of the island of Pulau Bidan, where it is evidently one of the commoner species.

The body of this worm is rather elongated, rounded in front and with a pointed hinder extremity. The arrangement of its eye-spots is shown in the accompanying figure (text-fig. 50).

Text-fig. 50.

Eye-spots of *Notoplana evansii*.

Unfortunately I have no notes as to colour, but, judging from the spirit-specimens, the creature is probably of a yellowish-grey colour, with a small number of irregularly scattered black spots. The gut-branches are numerous, and there is no anastomosis.

The dimensions of an average individual are as follows :—

Length	25	mm.
Breadth	15	,,
Tentacles from ant. margin	5	,,
Mouth-opening ,,	12	,,
♂. Aperture behind mouth	3·5	,,
♀. ,, behind male	1·5	,,

Genital Apparatus (see text-fig. 51, 304).

The most striking features of the male copulatory apparatus are the great length of the antral chamber and the chambered prostate organ, the latter recalling the prostate of certain Leptoplanas, e. g. *L. alcinoi*. From the male aperture the antral cavity (text-fig. 51, *a.m.*) extends forwards as far as the level of the hinder end of the pharynx. It has very muscular walls and runs sloping in an upward direction. Lang, in his diagram of the genital apparatus of *Hoploplana* (*Planocera insignis* group [6]), calls this chamber the penis-sheath ("Penisscheide), but this term should, I think, be reserved for the sheath-like folds of the walls of the antral chamber occurring in *Cestoplana* and in certain Cotylean genera.

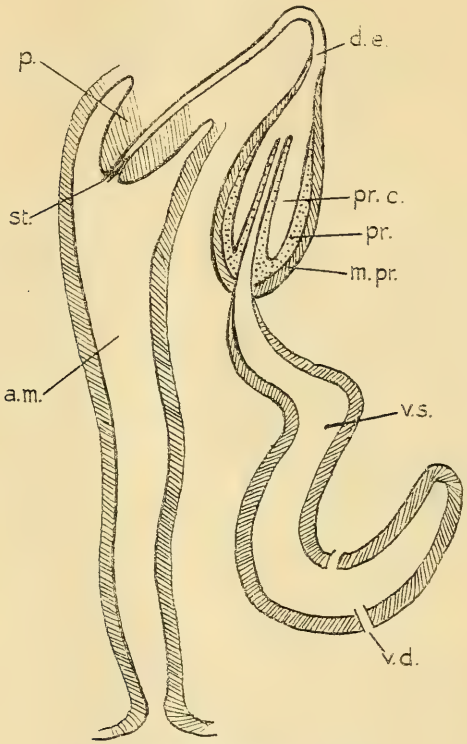
The lining of the walls of the antral chamber in the present species consists of a flattened ciliated (?) epithelium; the muscular wall consists of a thick layer of interlacing circular fibres.

The penis (*p.*) itself is small and projects into the antral chamber at the upper anterior end of the latter.

The penis is a fleshy organ, composed of longitudinal and circular fibres which exhibit numerous nuclei (see Plate XXIII. fig. 2). It is armed with a chitinous stylet.

The base of the penis is entered by the short ductus ejaculatorius (*d.e.*) which leads to the prostate region. It turns shortly after leaving the penis and runs in a backward direction, so that a

Text-fig. 51.



Male organs of *Notoplana evansii*.

For explanation of lettering, see p. 318.

transverse section passing through the penis passed also through the prostate (see Pl. XXIII. fig. 2 and also text-fig. 51).

The prostate consists of a number, some nine in all, of small chambers (*pr.c.*) which lie about the ductus ejaculatorius and open into it at their distal ends. The ductus, elsewhere with muscular walls, here is lined only with a very flattened epithelium, outside which lies a second layer of similar cells belonging to the

inner walls of the prostate chambers. Between each of these chambers a fine double septum runs out from this inner wall (Plate XXIII. fig. 2, *s.*). The prostate cells stain very feebly, and the lumen of each chamber is well defined, and contains in most cases a certain amount of secreted matter. Outside the chambers is a fairly thick layer of circular muscle-fibres, and, beyond these, an ill-defined layer of cells which appear to be glandular. Here and there are faint indications of processes from these outer glandular cells, piercing the muscle-layer of the prostate organ. This muscle-layer is also traversed by processes from the septa of the chambers. There is no longitudinal muscle-coat to the prostate.

Towards the level where the prostate-chambers open into the ductus ejaculatorius, some of them open into each other, so that the number of chambers seen in cross-section is reduced to four or five.

On the proximal, hinder, side of the prostate, the ductus is continued back into the vesicula seminalis (*v.s.*), which is long and contorted. It is lined with a ciliated epithelium, and its walls are composed of regularly arranged circular muscle-fibres. At its extreme hinder end it turns sharply forward and ends blindly. Just before it takes this turn forward, the two vasa deferentia open into it, one on either side, after piercing through its muscular wall.

There is a spacious antrum femininum surrounded by the large shell-glands, the secretions of which it receives. The vagina leaves the antrum dorsally, and runs forward for the first part of its course through the shell-glands, the secretion of which it also receives. It then turns first dorsalwards and then backwards, acquiring in its course a fine wall of circular muscle-fibres. After running back for a short distance, it receives the short common duct from the two uteri. It then continues to run back as far as the level of the antrum femininum, where it ends blindly.

It is evident that this species is closely allied to von Plehn's *Plagiotata promiscua* [7]; in fact, the terminal parts of the male apparatus in the two species have almost identically the same structure.

It differs from von Plehn's species in having the pharynx of the normal type, not elongated transversely. This character is of sufficient importance to justify the placing of these species in two separate genera. In addition *Notoplana* is characterised by differences in the female apparatus, and by the great length of the antral chamber of the male organ.

The genus *Notoplana* may be defined, then, as follows:—

A Planoceroid genus with styliform penis and without a bursa copulatrix. The male antral chamber is very long; there is a complicated prostatic organ consisting of several chambers lying around the ductus ejaculatorius in front of the vesicula seminalis. The latter is long and twisted. Body rather elongate, without marginal eyes; mouth-opening rather behind the middle; pharynx normal; gut-branches numerous, without anastomosis.

Family Leptoplanidæ.

Leptoplana malayana, sp. n. (Plate XXIII. fig. 3.)

A number of specimens; some, preserved in formol, are of a uniform greyish-brown.

Length, about.....	35 mm.	
Eyes, about	8 „	from the anterior end.
Mouth-opening, about	15 „	„ „
♂ aperture, about ...	10 „	from the hinder end.
♀ „ „ ...	1 „	from male.

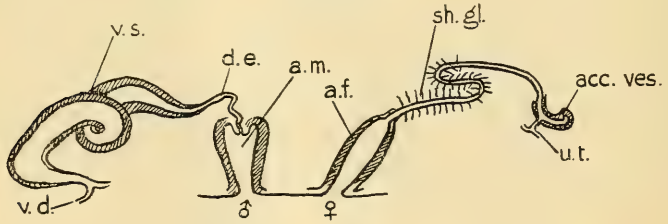
The arrangement of the eye-spots is that usual in the genus: there are two small clusters of "tentacle-eyes" about 1·5 mm. apart, and in front of these are a few scattered spots on either side of the middle line.

This species is closely allied to *L. pacificola* von Plehn [7].

Genital Apparatus (see text-fig. 52).

The vasa deferentia (*v.d.*) open into the proximal (anterior) end of the vesicula seminalis (*v.s.*); the latter, of considerable length and much twisted, is lined with ciliated epithelium, and has thick

Text-fig. 52.



Genital apparatus of *Leptoplana malayana*.
a.f., antrum femininum; *acc.ves.*, accessory vesicle; *sh.gl.*, shell-glands; *u.t.*, uterine duct; *v.d.*, vasa deferentia. For other letters see p. 318.

muscular walls made up of circular fibres. At its distal end the vesicula narrows into the ductus ejaculatorius (*d.e.*), which is shorter, but, like the vesicula, much twisted. Its walls are like those of the vesicula, but it is much narrower and has a less well-developed muscle-layer. The penis is small, fleshy, and unarmed, and projects into the large antral chamber, which has thick muscular walls and extends vertically upwards almost to the level of the dorsal body-wall muscles. (See Plate XXIII. fig. 3.)

The female opening lies close behind the male, and leads into a moderately large antral chamber (*a.f.*) with muscular walls. Into this the vagina opens from above. This latter organ is a long and tortuous duct of varying diameter; the shell-glands (*sh.gl.*) open into it through nearly its whole length. At its hinder end, near

the point where the uteri open into it, the muscular walls, which are elsewhere feebly developed along its course, become thicker, but not very markedly so (cf. *L. californica* von Plehn). The two uteri (*ut.*) unite as they enter it from below, and behind them there is a very small accessory vesicle (*acc.ves.*) with muscular walls.

The genus *Leptoplana*, as at present constituted, contains a considerable number of species, many of them only referred by Lang with doubt to the genus. In the majority of the species, the anatomy of which has been investigated by means of serial sections, the genital apparatus presents the following characters :—

The penis is directed backwards. The vasa deferentia open into a muscular vesicula seminalis ; from this the ductus ejaculatorius runs backwards to open into a prostate organ, which may be chambered ; leaving this, the duct runs back into the penis, which may be armed with a chitinous stylet.

The vagina runs back from the antrum femininum, receives the secretion of the shell-glands, and further back the two uteri open into it ventrally, usually by a common duct. An accessory vesicle is generally present. The most familiar species of the genus, *L. tremellaris*, differs from the majority of species in the structure of its male apparatus sufficiently to permit us to put it on one side to form of itself a section of the genus further characterised by the possession of a ventral sucker between the genital openings. Another species, *L. subviridis* von Plehn [8] (=*L. pardalis* mihi [4]), approaches *Discocelis tigrina* in the structure of its female organs, and accordingly we may put this species also in a section apart.

The remaining species I have attempted to classify below, so far as is at present possible, according to the structure of the penis and prostate. I trust that I will not be thought to have laid too much stress on the structure of these organs in dealing with this or other genera. It seems to me that, of all the characters that present themselves for classifying this order of Turbellaria, these are the most useful, and that they are as reliable as any of the other characters employed for this purpose, such as structure of the pharynx, number and arrangement of eye-spots, presence or absence of tentacles, &c. &c.

I propose, then, to group the species in two sections, A, and B, so far as our knowledge of their anatomy permits :—

A. Penis provided with a stylet.

(*a*) Prostate complicated by radially arranged "Drusenkanäle."

1. *L. kukenthali* v. Plehn. Spitzbergen [7].

(*b*) Prostate divided into chambers lying parallel to the ductus ejaculatorius.

2. *L. vitrea* Lang. Mediterranean [6].
3. *L. alcinoi* Schmidt. ,, [6].

(*c*) Prostate not chambered.

4. *L. panamensis* v. Plehn. Gulf of Panama [7].
5. *L. californica* v. Plehn. California, Chatham Is. [11]
6. *L. nationalis* v. Plehn. Ascension Is. [8].

The following also belong to section A, but their position in the section cannot be determined without information as to the prostate characters.

L. variabilis Giard.
L. ellipsoides Verrill.
L. virilis Verrill. } New England [13].
L. dræbachensis Oersted. Norway [6].

L. fallax (de Quatrefages) [6] should perhaps form a separate section of the genus on account of the great length of its stylet. It occurs on the south side of the English Channel.

B. Penis unarmed.

a. Prostate chambered.

7. *L. chierchæ* von Plehn. Callao [7].

β. Prostate not chambered.

8. *L. pallida* (de Quatrefages). Mediterranean [6].
9. *sp.* (unnamed). Maldives [4].

γ. No definite prostate.

10. *L. pacificola* von Plehn. Valparaiso [7].
11. *L. malayana*, sp. n. Straits of Malacca.

Belonging to this section but of uncertain position in it is *L. angusta* Verrill [13] from New England. *L. lacteoalba* Verrill [14] is insufficiently characterised, but said to be like *L. pallida*.

Semonia penangensis, sp. n.

Two specimens from Pulau Bidan. No note available as to colour. This interesting species agrees fairly closely with the only other species of the genus at present known, viz., *S. maculata* von Plehn, from Java [7]. It is, however, readily distinguished from that species by its external characters, the arrangement of the eye-spots being obviously very different and showing some approximation to the condition found in *Discocelis tigrina* (see text-fig. 53, p. 309).

The dimensions of the larger specimen are as follows:—

Total length, about	22	mm.	
Breadth, about	11	„	
Mouth-opening, about ...	9	„	from the hind end.
Genital aperture	1	„	behind mouth-opening.
Brain, about	4	„	from the anterior margin.

The marginal eyes extend back for about 8 mm. on either side. The arrangement of the brain and tentacle-eyes is shown in text-fig. 53, p. 309.

An important distinction between this species and *Semonia maculata* is afforded by the fact that in the latter the testes and

ovaries lie on the dorsal side of the body (see von Plehn [7]), whilst in the present species the position of the testes is normal. *i. e.* on the ventral side.

In one or two respects this species approaches the closely allied *Discocelis tigrina*, and is perhaps intermediate between that species and *S. maculata*. But the latter species is also certainly closely allied to *Discocelis*, and I am rather surprised to find that von Plehn has not instituted any comparison between the two genera. *S. penangensis* differs from *S. maculata*, and approaches *Discocelis tigrina*, not only in the features already mentioned, viz., the arrangement of the eye-spots and the position of the testes, but also in that the uteri unite to enter the vagina by a short common duct, and in having a very blunt, almost square penis.

Text-fig. 53.

"Brain-eyes" of *Semonia penangensis*.

It differs from *Discocelis*, and resembles *S. maculata*, in being without the characteristic large prostatic cells which occur in the epithelium of the penis and of the antrum, and without the remarkable paired structures which run forward from the accessory vesicle of *Discocelis tigrina*. Further, like *S. maculata*, it possesses a definite vesicula seminalis, which appears to be absent in *Discocelis*.

Lastly, *S. penangensis* is without the curious glandular vesicles found along the anterior ends of the vasa deferentia in *S. maculata*; and the vagina is prolonged, beyond the point where it receives the openings of the uteri, into a very small accessory vesicle—so small, in fact, that it almost escaped observation. This may be due to the fact that the only specimen available for section-cutting was not quite mature; or more probably, since the uteri were full of apparently ripe eggs, that this organ is undergoing degeneration.

It is obvious that the distinction between *Discocelis* and *Semonia* is a very slender one, but still, I think, sufficient to warrant the retention of the latter as a valid genus. The most important characters separating the two genera are the absence of a vesicula seminalis in *Discocelis*, and the curious horseshoe shape of the accessory vesicle in that genus.

Family Cryptocelididæ.

Bergendalia anomala, gen. et sp. nov. (Plate XXIII. figs. 4, 5, 6, & 8.)

A most remarkable and interesting form, probably allied to the anomalous genera *Cryptocelides* and *Polypostia*, described by Bergendal [1], and provisionally referred to the same family with them.

The structure of the female terminal ducts is, so far as I know, unique, and approached only by the species referred to *Trigonoporus* and *Polyporus* (see von Plehn [11]).

Only a single specimen was obtained. It is rather a large form, with a total length of about 60 mm. and breadth about 27 mm. The mouth-opening is some 15 mm. from the hind end, and the genital pores lie halfway between these two points.

The margin of the body is complete, surrounded by a continuous rather dense row of eye-spots. There are none of these, apparently, over the brain.

Colour in the spirit-specimen uniformly greyish white (see Pl. XXIII. fig. 8). The specimen appears to be in an early stage of sexual maturity, since no trace of ovaries or testes can be discovered.

The pharynx is large and much folded, the gut-branches are numerous and anastomose freely.

The cells of the epidermis are elongated, especially on the dorsal surface. True rhabdites are absent, but in place of them the epidermal cells are crowded with pseudorhabdites which are of a coarsely granular texture, faintly stained and columnar in shape. In my sections (stained with Grenacher's hæmatoxylin) certain gland-cells lying within the muscle-layers of the body-wall, especially on the ventral side, are deeply stained; from these cells run processes which pierce the muscle-layers and basement-membrane, and make their way to the surface through the epidermal cells. These deeply-lying gland-cells and their processes have rather a spongy appearance, due to their preservation not being quite perfect.

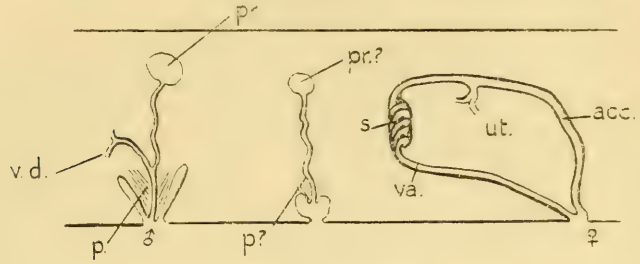
Genital Organs (text-fig. 54, p. 311).

The penis (*p.*) is a small fleshy organ composed of nucleated longitudinal fibres (Pl. XXIII. fig. 4). Its outer side is lined with cells continuous with those lining the antrum masculinum, but whereas the latter are ciliated, those covering the penis are non-ciliated. The base of the penis is pierced by a duct running nearly vertically upwards. Immediately after leaving the penis this is joined by two small ducts—the vasa deferentia (*v.d.*)—which run forward on either side of the middle line. In one of them, at the level of the hinder end of the pharynx, there is a slight dilatation containing spermatozoa.

The vesicula (*pr.*) lying above the penis is small. Its wall

consists of a very thin layer of circular muscle-fibres, lined with a cubical epithelium, the nuclei of the cells of which lie close to the lumen, and which has rather the appearance of an exhausted secretory tissue. This organ I call the prostate (Pl. XXIII. fig. 4, *pro.*). About halfway between the penis and female aperture lies an organ which bears some resemblance to the penis already described. This organ constitutes one of the most interesting features of this anomalous species. It consists of a small protrusible penis-like organ (*p.*?), about one-third the size of that first described, lying in a small antrum. It is pierced by a short duct, which runs into it from a small non-muscular vesicle which lies immediately above it (*pr.*?). This small vesicle is of about the same size as the prostate. There is no communication, so far as I can discover, between the duct connecting these structures and the vasa deferentia (Pl. XXIII. fig. 5).

Text-fig. 54.



Genital apparatus of *Bergendalia anomala*.

acc., accessory part of vagina; *p.*?, penis-like organ; *pr.*?, prostate-like organ; *s.*, spiral coils of vagina. For other letters, see p. 318.

I can suggest only two explanations of the presence of this second penis-like organ and its accessories.

Firstly, that it may be regarded as a prostatic structure which has lost its connection with the penis and developed an intromittent terminal part of its own. Such a state of affairs is found in the Cotylean family Diposthiidæ; but in that case both penis and prostate open into a common antrum, and there is what appears to be a prostate gland in connection with the penis in *Bergendalia*, a fact which makes strongly against this view.

The second possible explanation is that the organs under discussion are the vestiges of a second penis. The fact that they bear a close resemblance to the functional penis tends to support this view, as does also, I think, a comparison with *Cryptocelides* of Bergendal [1].

This is the only other Polyclad described, so far as I know, in which two penial organs lie behind each other on the middle line; but, according to Bergendal, they lie behind the female aperture, and, further, both open into a common antrum, whilst in some cases

there may be four or even six penes present. In another genus presumably allied to this, viz. *Polypostia* Bergendal [1], the penes lie in large numbers around the female aperture.

The female apparatus is no less remarkable than that of the male. The vagina (*va.*) runs forward for some little distance from the aperture, then turns upwards. As it does so, it is twisted into a remarkable spiral coil, making some five complete turns. It then runs backwards, narrows considerably, and soon receives the openings of the two uteri (*ut.*) on its ventral side. Beyond this point it is continued back as a narrow accessory vesicle (*acc.ves.*) about as far as the level of the female aperture, when it turns sharply ventralwards and *opens to the exterior by the antrum.*

The only other Polyclads with which I am acquainted that possess a secondary female opening are *Trigonoporus* of Lang [6] and *Polyporus* of von Plehn [11], but in both these cases the second opening is quite distinct from the primary one (the true antrum femininum).

The curious spiral twisting of the vagina in the present species is, so far as I know, unparalleled in the order.

For the first part of its course, *i. e.* whilst it is running forwards, the vagina is lined with elongated columnar ciliated cells, the nuclei of which lie near their bases. Outside this epithelium is a thin layer of circular muscle-fibres, and beyond these, in my sections, can be seen a great number of nuclei massed round the vagina, and probably belonging to gland-cells. Where the vagina turns dorsalwards and becomes spirally twisted it has narrowed slightly, but its epithelium retains the characters already mentioned. The muscle-sheath does not follow the individual folds of the spiral, but forms a continuous covering for that part of the duct (Pl. XXIII. fig. 6, *m.s.*). The rest of the terminal female ducts are precisely similar in character to the first part of the vagina, only narrower. There seem to be no special shell-glands present.

The genus may be defined as an *Acotylean genus in which behind the functional penis a small second penial organ occurs. The accessory vesicle of the female apparatus opens to the exterior through the antrum femininum. Body pointed at either end. Marginal eye-spots present; mouth subcentral.*

Family Latocestidæ.

Latocestus argus, sp. n.

Four specimens were collected by Mr. Evans. One of these is labelled "Chocolate-brown above, slightly lighter below."

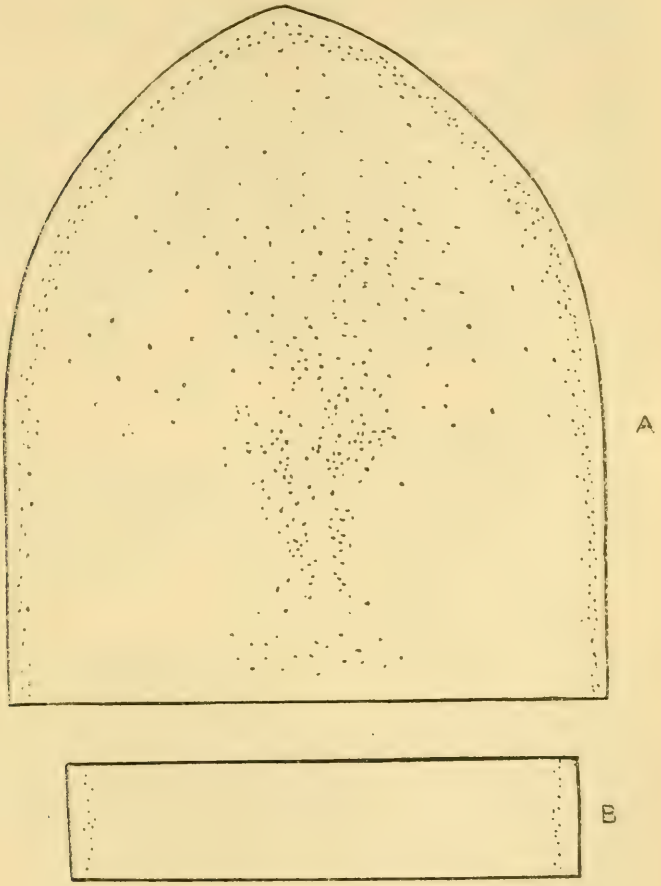
The largest specimen has a total length of about 30 mm. and a breadth of 5 mm. The mouth is 2·5 mm. from the hinder end of the body.

This species is proportionately longer than the other member of the genus which I have had an opportunity of examining. Its most striking feature is the presence of a crowded row of eye-spots running completely round the margin of the body. The

arrangement of the eyes at the anterior end of the body is shown in text-fig. 55 A and towards the hinder end in 55 B.

The only other elongate form exhibiting this character with which I am acquainted is *Cestoplana ? maldivensis* mihi. This is almost certainly a *Latocestus*.

Text-fig. 55.



Eye-spots of *Latocestus argus*.

I can detect no rhabdites in the epidermis. The parenchyma is very dense, and nervous tissue abundant on the ventral side just within the body-wall muscles.

The terminal parts of the reproductive apparatus are almost exactly similar to those figured by von Plehn [7] for *Latocestus pacificus*.

As in that species, the testes as well as the ovaries lie on the dorsal side of the body.

THYSANOZOON AUROPUNCTATUM Coll.

Thysanozoon auropunctatum Lang [6]; von Stummer-Traunfels [13].

One specimen, unfortunately immature and in a poor state of preservation, although it has retained its colour fairly well.

PSEUDOCEROS BEDFORDI, sp. n. (Plate XXIII. fig. 9.)

This strikingly handsome and large species was obtained by Messrs. Lanchester and Bedford in Singapore Harbour. The single specimen, kindly given me by Mr. Lanchester, was unfortunately in fragments and fully one-half of the specimen missing, so that a satisfactory examination was not possible. I believe, however, that it was provided with a pair of penes. The colouring is very beautiful, and quite sufficiently marked to render the identification of this species in the future a simple matter, thanks to the careful drawing for which I am indebted to Miss Dust.

On the label accompanying the specimen is written "Singapore Harbour, from tide-marks to 10 faths." I venture to associate with this species the name of my lamented friend the late Mr. Bedford.

PSEUDOCEROS COLLINGWOODI, sp. n.

Closely allied to *Ps. cerebralis* (Kelaart) and *Ps. striatus* (Kelaart), but smaller than either. It has the same regular convolutions at the margin of the body that are shown in Collingwood's figures, and the coloration is similar especially to *Ps. cerebralis*.

Length, about.....	30	mm.	
Breadth „	25	„	
Mouth-opening, about	3	„	from the anterior margin.
Sucker about	8	„	behind the mouth.

The specimen is immature and the penis is unpaired. Colour—dorsal surface mottled dark brown and brownish white. The extreme margin is white, but the white rim is exceedingly thin; just inside this is an equally fine black line. Ventral surface pale brownish white, becoming darker towards the margin, which is edged with black and white just as on the dorsal surface.

PSEUDOCEROS? RUBELLUS, sp. n. (Plate XXIII. fig. 10.)

A number of specimens of this very small species were collected. One of these was "found under a stone between tide-marks. It was magenta-red in colour. Nov. 1899." Though very small, these specimens appear for the most part to be mature. They bear a close resemblance to *Pseudoceros kelaartii* (Coll.) in colour, but the latter species is much larger and has the eye-spots arranged quite differently. The arrangement in the present species is shown

in fig. 10 of Plate XXIII. The tentacles also in Collingwood's species are much more prominent. The penis is unpaired. The body is nearly circular and the sucker median. Total length about 5 mm., breadth 4 mm. The arrangement of the eye-spots is very different from that normally found in *Pseudoceros*, but I cannot find any other characters distinguishing it from that genus.

At least two other species of this genus are represented in the collection. One of these is a very small individual of the *P. superbus*-group (perhaps *P. hancockianus*); whilst several specimens belong to a species coloured exactly as *Proceros concinnum* Coll., viz., they are blue, with orange margin and median stripe. They are, however, very much smaller, about 8 mm. to 10 mm. in length, and of a different shape, not pointed at their hinder end, and have small, folded tentacles, whereas Collingwood's species has pointed tentacles. *Proceros concinnum* in fact is almost certainly a Euryleptid, whilst these specimens are undoubtedly members of the genus *Pseudoceros*.

I prefer, however, not to name them at present.

Family Diposthidæ.

Asthenoceros, gen. nov.

Asthenoceros woodworthi, sp. n. (Plate XXIII. fig. 7.)

Two specimens, without notes as to colour; but, to judge from these spirit-specimens, the species is of a reddish-brown colour, darkest on the middle line.

Length, about ...	17 mm.	
Breadth.....	14 „	
Mouth-opening...	7 „	from the anterior margin.
Sucker	1·5 „	behind mouth.

The male and female apertures lie in the usual order between the "mouth" and sucker.

The pharynx is large and much folded, its opening being submedian. This feature will serve at a glance to distinguish this species from any of the Pseudoceridæ. In describing the type of the family, Woodworth [16] makes no statement as to the pharynx, but, to judge from the figure given, it is median or submedian as in the present species.

The body is flat and almost circular; the anterior margin is feebly folded, and there is a small group of eye-spots on either side of the middle line, but there are no very definite tentacles. The prostate body lies *in front of the penis*.

In this respect *Asthenoceros* differs from the type-genus *Diposthus*. There are no brain-eyes.

Only one of the two specimens was cut into sections, transversely; the other specimen appears, from an examination of it when cleared in oil of cloves, to be quite immature. The specimen serially cut presents certain peculiar features, which I am at

a loss to explain satisfactorily. In the first place, the testes and ovaries are very immature, and apparently only the terminal parts of the genital ducts are developed. On the other hand, there is, immediately over the penis, a large mass of mature spermatozoa lying in a chamber the character of which cannot be determined from my specimens, since it appears in places to have indications of a proper lining-epithelium of its own, and again in places seems to be merely a gap in the parenchymatous tissue. There are very faint indications of a duct running from this chamber down in the direction of the penis, but this duct cannot be traced far. Woodworth [16] suggests in connection with the specimens of *Diposthus* described by him, that they were in a late stage of sexual activity, and that in consequence of this the sexual organs were in a reduced condition. Possibly in my specimens of *Asthenoceros* a similar state of affairs occurs, but, as I have already stated, testes and ovaries in a very immature state are present. There is also a possibility that the ripe spermatozoa may be derived from another individual by hypodermic injection; but I do not think this is the case—firstly, because the penis is not armed with a stylet; and, secondly, because the spermatozoa lie over the penis, and because, as already stated, there are traces of a duct running towards the penis from the chamber in which they lie.

The terminal parts of the male apparatus histologically resemble those of *Diposthus*. The prostate and penis are separated into two distinct organs, "both of which are doubtless intromittent," both opening by a single gonopore. The prostate lies immediately in front, the penis directly over the aperture. It is rather feebly supplied with muscle-fibres, and the secretory cells lie in the middle of the organ, but there is no lumen apparent (cf. *Diposthus corallicola*).

The penis is much more muscular, and on the outer side has a very definite series of circular and longitudinal fibres. Nuclei in it too are much more numerous (Pl. XXIII. fig. 7).

In connection with the female organs there are traces of two pairs of uterine vesicles. The uteri are very small and difficult to distinguish from the surrounding tissue, and the ducts running to them are merely solid rods of cells of an embryonic appearance. The uteri open into the hinder end of the vagina. The antrum is deep, and widens at its upper end where it receives the secretion of the shell-glands.

The body epithelium is very densely crowded with small rhabdites, and on the dorsal side especially with pseudorhabdites. Scattered through the parenchyma, more particularly in the region of the sucker, are numbers of small rounded darkly-staining cells the nature of which is doubtful. The ventral surface of the body projects immediately behind the pharynx into a prominent median ridge which carries the gonopores and the sucker; behind the sucker the ridge disappears.

I have given as complete an account as possible of the cha-

racters of the genital organs, but, owing to the condition of the specimen, it is obviously far from being satisfactory, and in order to deal fully with this interesting species more material is necessary.

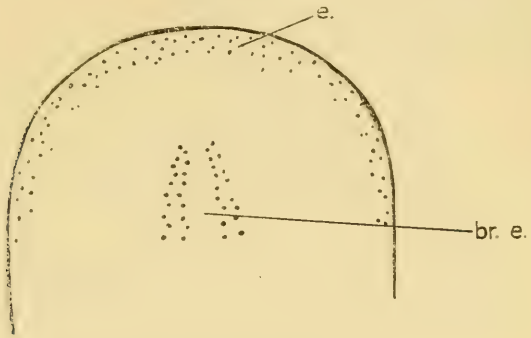
PROSTHIOSTOMUM PALLIDUM, sp. n.

One specimen, from the sea-shore, Dec. 1899.

Total length, about	20 mm.
Breadth, about	4 ,,

Anterior margin rounded. Arrangement of eye-spots shown in text-fig. 56.

Text-fig. 56.



Eye-spots of *Prosthiostomum pallidum*.
e, marginal; *br.e*, brain eye-spots.

Closely allied to *P. siphunculus* of the Mediterranean by the arrangement of the eye-spots, and agreeing with it apparently in being, so far as the spirit-specimen shows, of an uninterrupted dull grey-brown colour, it differs sufficiently in that the two rows of brain-eyes diverge continuously from one another from before backwards, whilst in the Mediterranean species these two rows converge at their middle.

It is also readily distinguishable, I think, from the latter species by its smaller size. The single specimen obtained by Mr. Evans is, to judge from the state of the sexual apparatus, fully mature. *P. siphunculus*, moreover, has the genital sexual organs relatively much smaller, to judge from Lang's figures (see Lang, 'Polycladida,' pl. 5. fig. 3).

P. pallidum is certainly very distinct from any species from the Indian Ocean that I have had the opportunity of studying, and also, I believe, from the species found in the Pacific.

I believe that *Leptoplana aurantiaca* of Collingwood is really a *Prosthiostomum*. It has the shape and proportions of a member of that genus, whilst its eye-spots have the characteristic *Prosthiostomum* arrangement. It may, of course, be identical with the

species described above, but, judging from Collingwood's figure, in the arrangement of the eye-spots it is sufficiently distinct.

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16. Woodworth. Bull. Mus. Comp. Anat. xxxii. 4, pp. 63–67, pl. i. (1897).

EXPLANATION OF PLATE XXIII.

Fig. 1. Spine from the lumen of the penis of *Planocera* sp., p. 302.
2. Section passing through the penis and prostate organ of *Notoplana evansii*, p. 302.
3. Transverse section through the penis of *Leptoplana malayana*, p. 306.
4. Transverse section through the penis and prostate gland (?) of *Bergendalia anomala*, p. 310.
5. Section through the rudimentary organ of penis-like structure of the same species, p. 311.
6. Section through the spiral part of the vagina of the same, p. 312.
7. Section across the antrum masculinum of *Asthenoceros woodworthi*, p. 315. These organs are directed obliquely forward, and consequently both appear in some of the sections. The granular appearance of the prostate in this region is rather exaggerated in the figure, but it becomes more marked towards its extremity.
8. *Bergendalia anomala*, p. 306.
9. *Pseudoceros bedfordi*, fragment of anterior part of body, p. 314.
10. *Pseudoceros? rubellus*, p. 314.

Explanation of Lettering of Plate and Text-figures.

a.m., antrum masculinum.
a.m.l., muscular walls of antrum masculinum.
d.e., ductus ejaculatorius.
d.pr., prostate duct.
ep., epidermis.
m.pr., muscular walls of prostate.
m.v., muscular sheath of vagina.
p., penis.
pp., vestigial penis ?
pr., prostatic cells.
pr.c., chamber of the prostate.
pro., prostate.
ppr., prostate-like organ.
s., septum between chamber of prostate.
st., stylet of penis.
t., tentacles.
va., lumen of vagina.
v.d., vasa deferentia.
v.s., vesicula seminalis.

4. On the Phylogenetic Cause of the Transposition of the Testes in Mammalia: with Remarks on the Evolution of the Diaphragm and the Metanephric Kidney. By W. Woodland, University College, London.[1]

[Received March 3, 1903.]

(Text-figure 57.)

The subject of the descent of the testes in Mammalia, notwithstanding its bionomic interest, has hitherto received but little attention from the phylogenetic standpoint; indeed, so far as I know, its interpretation has not hitherto been attempted. To exhibit the general nature of the problem and the apparent difficulty attending its solution, the following paragraph from Mr. Spencer's 'Principles of Biology' (vol. i. p. 573) may be quoted:—"But now let it be confessed that though all phenomena of organic evolution must fall within the lines above indicated, there remain many unsolved problems. Take as an instance the descent of the testes in the Mammalia. Neither direct nor indirect equilibration accounts for this. We cannot consider it an adaptive change, since there seems no way in which the production of sperm-cells, internally carried on in a bird, is made external by adjustment to the changed requirements of mammalian life. Nor can we ascribe it to survival of the fittest; for it is incredible that any mammal was ever advantaged in the struggle for life by this changed position of these organs. Contrariwise, the removal of them from a place of safety to a place of danger would seem to be negatived by natural selection. Nor can we regard the transposition as a concomitant of re-equilibration; since it can hardly be due to some change in the general physiological balance." I agree with Mr. Spencer that the descent of the testes can neither have been a change adaptive in nature, nor a result of the operation of natural selection; on the other hand, I must disagree with the statement that the phenomenon cannot be regarded "as a concomitant of re-equilibration," since, as will be shown, I attribute it to the direct action of the conditions of life found in the Mammalia.

To ensure due appreciation of the significance of the following statements, it will be as well to here indicate the nature of the theory about to be advanced. Of possible causes effecting the transposition of the testes, there are two categories: (*a*) causes which as regards their effects on the organism mediately or immediately impart advantage, so supplying the requisite material for natural selection; and (*b*) causes which in their effects on organisation bear no appreciable relation to either advantage or disadvantage. Since those of the former category are inconceivable in this connection, we are led to conclude

[1] Communicated by Prof. E. A. Minchin, F.Z.S.

that the transposition is an inevitable concomitant of some other constant feature of the animal's existence, thus not having arisen in relation to ulterior ends. Again, since the testes consist of ordinary matter possessing inertia and mass, their translation (involving rupture or distension of the mesorchium) implies mechanical force. From both of the foregoing considerations, and from the fact that no other efficient cause is imaginable, it is probable that the displacement results from the reaction on the part of the testes to the incident forces, which, it can be shown, are generated by bodily activity under mammalian conditions of life. The theory here advocated is to the effect that the descent of the testes in the Mammalia has been produced by the action of mechanical strains causing rupture of the mesorchial attachments, such strains being due to the inertia of the organs reacting to the impulsiveness involved in the activity of the animals composing the group.

Mechanical Aspects of Organisation.

Before entering upon a discussion as to the production of the forces above mentioned and the manner in which they have acted, it is well briefly to outline the entire argument from the mechanical standpoint. In the first place, accelerations imparted to the body as a whole generate strains (or stresses) in connection with the attachment or other means of support of every component viscus, and the degree of such accelerations (and therefore of the strains and stresses) is obviously dependent upon the reaction which occurs between the animal's body and the medium in or substratum on which it is supported, being directly proportional to the product of the powers of resistance possessed by the substances constituting the same. Secondly, it must be pointed out that the accelerations to which we refer, and to which alone we attribute any importance, are those involved in the impulses communicated to the body during the actual continuance of locomotion, and which inevitably result from the mode of action of the propelling agency, whatever its nature. The ordinary non-impulsive accelerations involved in the starting of an animal into motion from a state of rest, or its converse, do not concern us. In considering, however, the arboreal habits of *e. g.* Primates, the case is different, accelerations involved in motion from rest here being decidedly impulsive in nature. Now, among the Vertebrata, it is evident that fishes, aquatic amphibia, and birds severally exist in media which, owing to their mobility, negative the occurrence of accelerations of high degree, *i. e.* impulsiveness. Hence, as regards these accelerations, we have to consider only terrestrial animals, which come into contact with a substratum possessing sufficient power of resistance to afford a reaction of marked intensity. Of these terrestrial animals the mammalian group is at once distinguished from terrestrial Amphibia and Reptilia, both by the high degree of activity which

its members exhibit, and by the more perfect adaptation of the body (relation of limbs to trunk, &c.) to the locomotion in which the superior activity is mainly manifested. Consequently, in mammals, the reactions which occur between the organism and the substratum vastly exceed in magnitude those occurring in lower groups, and we have in this distinction a factor which in considering bodily conformation is worthy of all attention. Since in mammals the organisation is subject to such considerable forces, it follows that if stability of position be required in connection with organs possessing appreciable mass, *i. e.* if these organs are to adjust themselves to those transposing influences which arise out of impulsiveness, fixative structures must be developed in response to the demand. For, as remarked above, a sudden acceleration imparted to the body is necessarily transmitted to an attached organ through its attachment, which, if the organ be of considerable mass, is thereby subjected to an intense strain, possibly ending in disruption. Stability of position of an organ may be necessitated either on mechanical or physiological grounds: thus, apart from considerations of function, viscera of large mass (stomach, liver, intestine) must conform, as regards situation in the body-cavity, to the principle that, *cæteris paribus*, the more anterior the centre of gravity of the body the greater the facility of progression[1]; and again, from the functional standpoint, the kidneys must in active animals be maintained anteriorly in order to ensure proximity to a vigorous blood-supply. It will be evident from this, that if the position of an organ be of no economic moment—if there be no need of localisation either on account of mass or volume for preservation of bodily equilibrium, or on account of nature of function for physiological efficiency,—retentive structures will not tend to be formed, and the organ, if of sufficient mass, will respond by transposition to any considerable force incident upon it—a trait which in the course of generations will be inherited.

I shall now proceed to examine more in detail the production of the forces hitherto assumed to be capable of effecting the transposition of the testes—to enquire whether the intensity and direction of these forces are such as are congruous with the hypothesis advocated.

Mammalian Locomotion.

In view of the importance that is here attached to the character of mammalian locomotion, it is needful to discuss the subject in detail. Every unsupported mass descends to the earth with a given acceleration, and the magnitude of the force required to re-elevate the body to its initial position is directly proportional

[1] Well shown by measurements of the position of the centre of gravity in Pisces, and by the abdominal contours of active cursorial mammals as compared with those of species more slothful in habit (compare *e. g.* a greyhound or race-horse with a St. Bernard or cart-horse, or, more generally, herbivores with carnivores, though the different capacities of the digestive organs have here to be considered).

to the height through which upheaval is effected, and inversely proportional to the period of time occupied by upheaval. This statement in its application to terrestrial locomotion provides the clue for the solution of the present problem. With the exception of aquatic organisms, which exist in a medium so similar in density to themselves that the influence of gravity is not felt, all animals which fly, crawl, leap, or run are subject to this primary condition of self-support imposed by the earth's attraction. In Aves the body is not entirely unsupported, the resistance of the air to the large expanse of body yielding considerable aid in this respect, and the small amount of self-sustainment needed can be provided by the minor elevations imparted by individual strokes of the wing. The reactions between the wing and the air are of necessity small, owing to the mobility of the latter substance, and hence, in spite of the great activity of birds, no great accelerations are imparted to the body —the locomotion is not impulsive. The conditions affecting terrestrial locomotion are exceedingly unlike. Here, as before remarked, the powers of resistance possessed by the substances of organism and substratum both being of high degree, reaction between the two is correspondingly great. In Reptilia and (excepting the saltatory Anura referred to below) terrestrial Amphibia, however, the forces involved in locomotion are not conspicuous for their intensity, owing both to the fact that the period of upheaval is prolonged (no *sudden* impact occurring between the limbs and the earth) and the small amount of elevation effected by the action of the limbs, these two features resulting from the conformation of the body and the general inactivity of the animal. In Mammalia, on the other hand, the period occupied by contact of the limbs with the earth is extremely brief and the height of elevation considerable; and hence, though the angulation of the limbs tends to diminish concussion, the organisation is subject to the intense strains and stresses resulting from the enormous forces generated during locomotion. Consider the gallop of a typical Ungulate or Carnivore. The elongated trunk possessing two pairs of limbs, each pair being in an opposite phase of motion compared with the other, it follows that the two halves of the trunk will alternately be upheaved through a considerable distance on contact with the earth being made by their respective pairs of limbs, and depressed in the interval which exists between successive contacts. That is, the pendulous swing of each pair of extremities is accompanied by an elevatory impulse at the centre of the arc each describes, and these impulses effect the upheavals of the respective halves of the body through the distances which they have fallen in the time required for each pair of limbs to describe twice the length of its appropriate path. Considering the mode of action of either pair of limbs, and beginning at the horizontal stage of the trunk's position when the half of the body is being depressed under the influence of gravity, this continues to descend until the

limbs make contact with the earth, when, as already described, the entire portion of the trunk is suddenly upheaved with considerable force. If the horizontal velocity could be reckoned as constant, the only accelerations which the trunk would acquire would be in a vertical line; but since the horizontal velocity is a quantity which, owing to the resistance of the air, is continually decreasing, the upward acceleration suddenly imparted to the trunk at each contact of the limbs with the earth has to be compounded with a sudden forward acceleration in order to maintain the pace, and hence the resultant acceleration which the half of the body acquires at every upheaval is in an *upward* and *forward* direction. It is most essential to recognise this fact that the body as a whole has periodically imparted to it large accelerations in these two directions. As is obvious, the upward and horizontal velocities due to these accelerations become respectively neutralised by gravity and atmospheric resistance at the middle and end of the interval which exists between successive contacts of the limbs with the earth. From the instant when the maximum elevation of the half of the trunk is attained, *i. e.* when the upward velocity is completely neutralised, until contact again occurs, the body continues to acquire a downward acceleration due to gravity. But on contact taking place, the large downward velocity due to this acceleration is suddenly destroyed, and as suddenly exchanged for an equal upward velocity, in the brief instant of time occupied by the impact of limbs and earth. Whence it is evident that the degree of upward acceleration imparted to the half of the body during the sudden loss and gain of downward and upward velocities must be considerable. It is noteworthy that whereas each *forward* acceleration, due to either pair of limbs, is imparted to the body as a whole, each *upward* acceleration is solely imparted to that portion of the trunk to which the pair of limbs causing the elevation belongs; and hence the attachments of those organs situated in the median portion of the trunk are evidently not so subject to downward strains as in the case of organs placed more terminally. Thus it is important to notice, with regard to what follows, that the primitive pre-mammalian portion of the testes is decidedly posterior (see diagram, p. 334), and that in consequence the motion of the hind portion of the body is the factor of most importance in the consideration of the present problem.

From the foregoing, it is sufficiently manifest that at each elevation of the body in mammals a considerable force is imparted to the organisation as a whole (and by necessary implication to its constituent parts) in an upward and forward direction—as was to be proved. If the constituent parts of the body be considered, it will be evident that such a force works differential effects among them. For these organs, largely differing among themselves in regard to mass, and the same force being incident on all, it follows that the individual reactions are different, and hence there exists a tendency to segregation of those organs of greater mass from those of less. Moreover, organs differ *inter se* in their relation

to the rest of the body. If an organ be imbedded or otherwise firmly affixed to the main bulk, it will on account of its large area of attachment and close apposition readily share both the elevations and depressions incurred in locomotion—the strains and stresses are distributed in space and time, and hence their intensity is lessened; if, on the other hand, a massive organ be merely suspended from the main mass of the body, such a condition subjects the attachment to the influence of severe strains periodically recurring, the direction of which approaches that of the resultant acceleration of the trunk during its impulsive elevation. The great severity of these strains on the attachment of an organ thus disposed will be more fully realised if it be remembered that, on the sudden elevation of the body, the organ possesses the downward velocity due to the previous depression—a momentum which in being destroyed throws additional strain on the means of support. As will be seen, the preceding remarks apply in an eminent degree to the testes.

The Genitalia of Mammalia.

The reproductive organs of the Mammalia are relatively small bodies of great density and, in the case of the males, compactness, and they primitively occupy a position similar to that found in the lower Vertebrata. It is, however, characteristic of the majority of the Mammalia that in the course of development the testes forsake their primitive lodgment, and migrate posteriorly and ventrally to the terminal periphery, where they protrude at the surface of the body-wall. This protrusion constitutes the scrotum, in the wide sense of the term, which may vary in character from that of a pair of small slightly-elevated areas to that of a capacious oval pedunculated sac. Apparently in man alone the section of the cœlom contained within the scrotum becomes completely separated off from the main cavity; in other mammals, communication is retained by means of the inguinal canal, which, however, is usually narrow, so negativing return of the testes to the main body-cavity. This feature in the case of active mammals possessing large testes is very important, since if the unattached organs were permitted to return to the main cavity, the forces to which they would be exposed during locomotion would doubtless be exceedingly detrimental—a malinfluence which both the narrowing of the inguinal canal and the possible tractive function of the gubernaculum during development safeguard against. In fact, contrary to the usual supposition, the internal and not the external situation of the testes is the source of danger. It will also be observed that in small animals which do not possess narrow inguinal canals, there is no such dire necessity for the restriction of the testes to the scrotal cavity, both on account of the smaller size of the organs and the usually less intense forces to which the testes are subjected. Thus, paradoxical as it may seem, the increased protrusion of the testes

beyond the surface of the body-wall, besides being a necessary result of more massive organs and the incidence of more powerful forces, is in itself a further means of preservation. In physical character, the testes, as already mentioned, are definite bodies of concentrated form, suspended dorsally in the body-cavity by the thin mesorchial membrane. Also investigation shows that, with the exception of the heart, the testes are the densest organs in the vertebrate body, and hence, as they possess appreciable volume, their mass is also considerable. Moreover, the testes (and ovaries) are distinctly separated from the remainder of the body, this separation (lending additional facility to transposition) arising out of the fact that the gonads are from their very nature individualised, reproduction essentially consisting of the separating off of a portion of the organism; and hence the body primarily serves as a mere carrier of these organs, which, unlike the kidneys *e. g.*, bear no relation to the economy of the animal. From this it follows that the transposition of the testes is of no concern to the rest of the organism, since the process can cause no derangement of function in other portions of the body; and hence the testes, differing from all other organs in this respect, do not, under ordinary conditions, require to be retained in their primitive position by the special development of fixative structures. Thus, as regards their definiteness and concentration of form, their means of suspension, their superior density, and their structural and physiological separateness from the rest of the organism, the testes fully conform to the above-specified conditions favourable to transposition. The transposition of the testes occurring under conditions which permit the descent of these organs alone (and the testes alone have descended), and a cause capable of effecting this transposition solely existing in the Mammalia (in which group descent has alone occurred), it is probable that the latter phenomenon is the cause of the former. I hold that, in the majority of the Mammalia, the testis attachment has throughout the history of the race been constantly subjected to severe strains consequent on the character and conditions of mammalian locomotion, and that on account of the resulting disruption or distension of the mesorchium, the testis has migrated in a postero-ventral line (*i. e.* in an opposite direction to the forward and upward accelerations imparted), coming to lie at the terminal periphery of the body-wall and forming the scrotal protrusion. Just as when a man runs, a weight in his coat-pocket will periodically "drag" and ultimately wear a hole in the lining by constant distension, so the testis of mammals has responded to like forces resulting in "descent."

I now proceed to consider the genital organs of the Mammalia as a whole, the general conformation of which amply confirms the foregoing conclusion, tending to show that the testes have, in every case, reacted in a degree proportional to the forces concerned. Indeed, the general correspondence between situation of the testes and grade of impulsiveness displayed in the various

orders and families of the Mammalia affords such conclusive evidence as to the causal relation subsisting between the two that a systematic review of this evidence is well called for. That the correspondence is not absolute, however—that there exist instances of the concurrence of scrotal testes with sluggish habits —is without doubt mainly, if not wholly, to be explained by phylogenetic considerations. For it must be remembered that once the descent of the testes is inherited, the trait is a constant one (unless acquired sluggishness is able in time to produce effect, which is doubtful), and remains so in successive generations whatever varied habits may be assumed, unless the bionomic aspect so changes that natural selection cancels the "plus variations," so affording an ascendancy to reversionary factors. That such has been the case in several instances will be illustrated below.

In the Monotremes the activity (impulsiveness) is of a very low degree. *Ornithorhynchus* is "aquatic in its habits, passing most of its time in the water or close to the margin of lakes and streams." The "body is rather long, compact, and almost everywhere of the same thickness. It rests on short, massive legs . . . . . so short that the animal in walking or running actually drags its body along the ground." *Echidna* is "usually found in rocky districts, and more especially in the mountains . . . . . and is mainly of nocturnal habits." It is described as "indolent." The testes in both instances are "abdominal in position throughout life," and afford the only example in mammals of a disposition of these organs anterior to the kidneys. The low status of these animals is well known.

In the Marsupials "the testes are always contained in a scrotum, which is suspended by a narrow pedicle to the abdomen in front of the penis." If it is permissible to assume that the ancestor of the marsupials was kangaroo-like, the pre-penial position of the testes may perhaps be attributed to the peculiar mode of locomotion characterising this animal. For the rapid locomotion of a Kangaroo consists of a series of leaps, and such leaps would involve, as in ordinary mammals, a series of antero-dorsal tensions on the suspensory membranes of the testes; but since the bodily depressions are marked by a more prolonged termination, as compared with those involved in the ordinary gallop, the testes would in addition tend to be thrown forward, and these two factors in conjunction have possibly led to the peculiar position of the testes found in marsupials. On no other theory than that of descent from an ancestor characterised by pre-penial testes can the peculiar genital conformation of the variously habited marsupials be correlated with special bionomic conditions; and hence, on this ground alone, it is possible, as implied above, that the ancestor of the Marsupialia was of the type of the Macropodidæ, the characteristic saltatory progression originating the pre-penial situation of the scrotum in the manner indicated.

The Edentata represent another ancient group. Their activity

in general is small. The Bradypodidæ are arboreal in habit, and are characterised by "habitual sluggishness," being "most inefficient walkers," and in climbing, never leaping from bough to bough (a form of activity involving more impulsiveness than even the gallop, but probably not more than that involved in saltation). Their testes are placed close to each other, lying on the rectum between it and the bladder; *i. e.* are retained in the abdomen. The Myrmecophagidæ are also not noted for activity, and their testes are disposed as in the Sloths. The Dasypodidæ are similarly inactive, being "harmless and inoffensive," endeavouring to escape by rapid burrowing. However, it is stated that "they can run with great rapidity." The testes are abdominal, lying "above the brim of the pelvis." The Manidæ are terrestrial and burrowing in habit, but some members of the group can climb trees. They are not very active. The testes lie in the inguinal canal. The Orycteropodidæ (Aard-varks or African Ant-eaters) are terrestrial and fossorial. Their testes are "inguinal, but they appear to descend, at all events temporarily, into a scrotum." Their phylogenetic position is uncertain. In the order Sirenia the testes, needless to say, are abdominal. These animals are "slow and inactive in their movements, mild, inoffensive," browsing at the bottom of water.

The piscine locomotion of the Cetacea sufficiently accounts for the abdominal position of their testes, which organs are placed in the proximity of the kidneys. Even assuming the terrestrial ancestor of the Cetacea to have been characterised by the externality of the testes (which is improbable considering their existing localisation), such would inevitably have assumed an internal position consequent on the serious risk of injury involved under Cetacean conditions.

The Rodents are comparatively small animals. In habit they are mostly terrestrial, but some are arboreal and some natatorial. "The testes in the rutting-season form projections in the groins, but (except in the Duplicidentata) do not completely leave the cavity of the abdomen," *i. e.* the scrotal elevations are not well-defined. The Duplicidentata comprise the Hares, Rabbits, and the Picas or Tailless Hares, all extremely active animals, the latter being described as "agile" and as living in crevices among rocks. The Simplicidentata comprise the remaining Rodents, the principal families of which are the following:— The Sciuridæ "vary between the two extremes presented by our ordinary squirrels, the agile climbers, and the sluggish, clumsy marmots, which live almost entirely underground." Assuming the statement to be correct that the condition of the testes is similar in each of these two divisions (which is doubtful), it is evident that the latter are specialised forms descended from active ancestors. The locomotion of the Dipodidæ resembles that of the marsupial Macropodidæ and insectivoran Macroscelidæ. "The whole structure is adapted for jumping, and we find resemblances in their structure on the one hand to the kangaroos, and on the other

hand to the jumping-shrews among the Insectivora." These animals, unlike the Macropodidæ, move their hind limbs alternately in the process of walking. Unfortunately the writer has been unable to discover detailed information with regard to the testes in these groups. Other families are the clumsy, thick-set Hystricidæ, the very active Castoridæ (Beavers), Myoxidæ (Dormice), and Muridæ. During the rutting-season the testes of Rodents migrate more posteriorly than at normal times; but this merely indicates a slight displacement probably due to the periodic enlargement of the organ, the cremaster muscle effecting return by decreasing the capacity of the scrotal emergence. This can be well seen in the Muridæ, where the slightest impact will cause a dislodgment of the testis.

The order Insectivora comprises "small animals . . . . . of very low type . . . . . belonging to the oldest mammalian stocks . . . . . which are generally terrestrial, although rarely of arboreal or aquatic habits . . . . . the greater number are cursorial." "In the subfamily *Centetinæ*, and *Chrysochloris*, the testes lie immediately behind the kidneys, but in others more or less within the pelvis; during the rutting-season they become greatly enlarged, forming protrusions in the inguinal region." The various families of this group afford good illustrations of the correlation of impulsiveness with degree of testis transposition. As stated above, in the *Centetinæ* or "Crawlers"—the appellation denoting their mode of locomotion—and *Chrysochloris*, which is inactive and fossorial, the testes lie just posterior to the kidneys, *i. e.* are abdominal. In the companion subfamily, the *Oryzorictinæ*, the two genera are represented by small animals—*Macrogale* being mouse-like with a long tail, and *Oryzorictes* mole-like in form. The testes are situated near the urethra. In the *Erinaceinæ* or Hedgehogs the testes are situated on the "underside of the inguinal canal." Their "movements are sluggish, their steps almost tottering, their gait clumsy." On the other hand, in the active Soricidæ (Shrews) and saltatorial Macroscelidæ (Jumping-Shrews), the testes project at the periphery of the perinæum, and in the Solenodontidæ, the feet of which are "formed for running," the "testes are received into perinæal pouches."

In the order Chiroptera, the members of which are so highly specialised for flight, there is "no scrotum, and the testes are either abdominal or inguinal." "We find in the low organization of their brain a proof of their inferior status"—a fact otherwise implied by the absence of the scrotum, unless a secondary retention has occurred owing to the danger of partial externality involved in the conditions of flight and position of the hind limbs.

The order Ungulata is subdivided into the Ungulata vera and the Subungulata. In the former suborder, needless to say, the testes of the large majority reside in a well-defined scrotum, corresponding to the eminent impulsiveness of the animals. In the Nasicornia (Rhinoceroses), however, the testes are inguinal, the tunica vaginalis communicating freely with the body-cavity. As

is well known, they are "huge, heavy, clumsy creatures, with bent legs so short that the belly seems almost to drag on the ground." The Subungulata comprise the Hyracoidea and the Proboscidea. The ancestry of the members of both these suborders is as yet undecided, their status, decidedly low in the scale, being obscure. The Hyracoidea are animals of about the size of a rabbit or somewhat larger, and "resemble small marmots." They possess a "short, fat body" with "weak and short feet." "In most species there is a complete adaptation to a life among the rocks," by possession of curious clinging habits resembling those of the Geckos. They are "agile in their sports, but rather lazy where food is abundant." Owen states that "the testes are abdominal, below or beyond the kidneys." The low status of the Proboscidea is shown by several anatomical traits, such *e. g.* as the possession of two venæ cavæ and the structure of the limbs. These animals have been well described as "peaceable colossi." Their gait is "pretty slow, though the Colossus can run very fast when once in full career, but this pace never lasts very long and is always maintained in a straight line." Owing to their huge size Elephants never gallop. The most active members are the "rejected males"—such extra activity thus being neutral so far as the inheritance of any tendency to testis descent is concerned. Elephants are vegetable feeders and are "gregarious, generally inoffensive and even timid, fond of shade and solitude and the neighbourhood of water." The testes are permanently abdominal —a fact explicable by habits, though phylogeny alone can afford a complete solution. Here, as possibly also in the case of the Nasicornia, it may be pointed out that the huge size of these animals itself implies inactive ancestors, for, according to one of the conditions of growth enumerated by Spencer, great activity is antagonistic to increase by bulk, and the occurrence of the latter negatives the past existence of the former.

The order Carnivora is subdivided into the Fissipedia and the Pinnipedia. The members of the former group are all exceedingly active animals of large size, and, together with the Ungulata, include the swiftest of terrestrial animals. Their testes, needless to say, reside in a well-defined scrotum. The Pinnipedia afford an interesting illustration of the secondary operation of natural selection. In the Otariidæ the "hind feet are turned forwards under the body, and aid in supporting and moving the trunk as in ordinary mammals . . . . . They spend more time on shore, and range inland to a greater distance than the true seals." In the Otariidæ the testes are "suspended in a distinct external scrotum"[1]. On the other hand, in the Phocidæ, "the hind limbs are directed so far backwards that they continue the horizontal direction of the vertebral column . . . . . They move on land only with difficulty by fixing themselves with their flippers in front and pulling up their hinder parts, then drawing their bodies up into a curve and

[1] Owen states that the scrotum is not distinct.

throwing their front parts again forwards. They drag their belly along the earth, show little suppleness, and soon become tired." There is no scrotum, the testes being abdominal and "imbedded in areolar tissue." Thus, as before maintained, the embryonic transposition of the testes tends to be checked if external conditions become so changed as to render complete descent of these organs disadvantageous to the animal, such being obviously the case in the Phocidæ, which have become further modified for an aquatic existence than the Otariidæ. It may be objected that ordinary mammals are subject, though in a less degree, to a like drawback —that their testes are also exposed to considerable danger, and that on the hypothesis descent ought to have been negatived by natural selection, *i. e.* by the development of ligaments or supporting areolar tissue. Incidentally noting that the actual facts prove that no such danger exists, it may be observed that the testes of a typical mammal are very efficiently screened, not only laterally by their position between the broad thighs of the hind limbs, but also posteriorly by the tail; and they are well preserved from contact with surrounding objects by the elevation of the body upon its limbs, the case being otherwise in Phocidæ, Cetacea, and lower animals.

The ancestral history and arboreal or other habits of the Primates constitute sufficient warrant for the conspicuous externality of their testes. That active arboreal habits involve impulsiveness of the highest degree, is sufficiently manifest on contemplating the movements of any of the ordinary monkeys, more especially in the case of the Gibbons.

Thus in a review of the Mammalia, we encounter a considerable mass of evidence testifying to the validity of the theory here advocated, and more might be added. In the Monotremata, Sirenia, Cetacea, most Edentata, Hyracoidea, Proboscidea, and Phocidæ, conditions prevail, or have prevailed, negativing the descent of the testes; and these conditions have either consisted of the absence of that type of terrestrial locomotion which has been the sole cause of the transposition of these organs, or of secondary factors which have either negatived the operation of the primary agency, or effected a reversion of the pre-existing effect of the same.

Since the transposition of the testes is mainly due to their mass, and definiteness and concentration of form—their means of suspension and physiological separateness from the body merely constituting conditions to the transposition—it follows that the small and diffuse ovaries of the Mammalia will not respond in any degree to the forces incident on the body, the magnitude of the strains on an attachment obviously being proportional to the mass of the organ attached. But apart from the smallness of mass possessed by the ovaries, there exists an important reason for their retention at or near the primitive position in the body-cavity. This reason is the necessity of the proximity of the ovary to the oviducal aperture for the conservation of the ova, the ovary

and the oviduct usually possessing no anatomical connection. How important this is may not only be inferred from *à priori* considerations, but also from the discovery of the many structural devices adapted to this end. Thus there occurs the "development of special folds of the peritoneum, which practically ensure the passage of the ova into the oviduct when they are extruded from the ovaries. The oviduct, moreover, has a large and fimbriated mouth, called in human anatomy the 'morsus diaboli.' This almost wraps round the ovary, and thus prevents the ova from straying in the wrong direction. Moreover, the ovary itself is often so arranged that it can easily be withdrawn into a pocket of the peritoneum, from which the obvious exit is by the gaping mouth of the oviduct. This disposition of the generative parts is still further modified in a few animals, such as the Rat and the Kinkajou. In these animals the mouth of the oviduct actually opens into the interior of a closed chamber which contains the ovary" (*Beddard*). Thus there exists ample reason for the retentive ligaments usually associated with the mammalian ovary (see Appendix).

The Genitalia and Conditions of Locomotion in Ichthyopsida and Sauropsida.

If, as we have observed, the conditions of mammalian locomotion alone subject the organisation to those concussive influences which have effected, among other changes, the transposition of the testes; and if, as we have also seen, only the highest manifestations of terrestrial activity are capable of producing complete testicular descent, then we may be certain that neither in the relatively inactive terrestrial Reptilia, the active aerial Aves, nor the aquatic Pisces will a like phenomenon occur. In Reptilia, though Ophidia and many Lacertilia are capable of brief spasms of great activity, the total impulsiveness is very small and of low degree. This is not only due to general passivity, but also to the fact that "the body of a reptile is, as it were, slung between its limbs like the body of an eighteenth century chariot between its four wheels," with resulting imperfection of the "relations of the limbs to the trunk from the point of view of a terrestrial creature" (*Beddard*). Apart from the absence of the causal conditions, the depression of the trunk and consequent liability of injury to the testes would in itself have negatived descent (*cf.* Phocidæ above).

In the Anura, the only terrestrial amphibia which concern us, adoption of terrestrial habits, resulting in a higher degree of impulsiveness, has as usual for its concomitants structural concentration and increased retentivity or transposition. Here the testes have assumed a "full oval form, compact and undivided: they are situated, as shown in the Frog, on the ventral side of the anterior half of the kidneys" (*Owen*). That the testes have slightly descended in correspondence with the saltatory

progression, is shown on comparison of two such forms as *Triton* and the Frog (see diagram below, p. 334). If, as we admit, anuran progression involves on a small scale those impulses to which we attribute the descent of the mammalian testes[1], why have not these organs migrated more than they have in this instance? In the first place, it may be contended that the total impulsiveness of a frog, though quite appreciable, is yet of small value as compared with that of a mammal of the same dimensions, say the Common Mouse. Secondly, the physiological and structural relations obtaining between the testes and the kidneys afford sufficient grounds for the special retention of the former, and, moreover, the firm attachment of the testis to the kidney is shielded from the abruptness of incident strains by the slight mobility of the latter organ. Finally, in addition to the above considerations, it is probable that the descent of the testes would here be prohibited in consequence of the depression of the hinder portion of the trunk and resulting proximity to the external surface. However, that such a cause for retention might be operative, it would obviously necessitate transposition to an extent that enabled the organs to experience adverse influences, and it is questionable as to whether they have travelled so far.

In the typical Aves, as in Mammalia, the expenditure of energy is very great, but in the former, as also in Pisces, aquatic Amphibia, &c., the bionomic conditions negative impulsiveness of locomotion, and their organisation is not subject to the kinetic influences which affect terrestrial animals.

One noteworthy subject is the large increase in volume of the testes during the brief courting-season: thus Owen provides a figure illustrating the periodic enlargement of these organs in the Common Sparrow, showing that their size ranges from that of a pin's head to that of a fair-sized marble, half an inch in diameter; and this same periodic increase of volume, though not so marked, occurs in sundry orders of the Mammalia, *e. g.* in Rodents and Insectivores. It is easily comprehensible that if an animal's activity, however impulsive, were largely restricted to the inter-breeding periods, the testes, possessing small mass during that time, would exhibit less tendency to displacement; but as yet it is not possible to decide whether this factor has any significance.

Connected with a consideration of the position of the testes in birds, is the important case involved by the habits of the Ostriches and their allies. The considerable speed attained by these birds, comparable indeed with that of the swiftest mammals, must involve a certain amount of impulsiveness; and such being the case, why have not the testes responded by descent? For the situation of the testes in Ostriches is normally avian, being "placed above and a little external to the kidneys," which latter structures are "elongated, flattened, glandular masses . . . . . lying deeply seated, and extending from the posterior edge of the diaphragm

[1] "The great Bull-Frog may clear six feet at a leap, and repeat them so rapidly as to escape a pursuer, unless chased at a great distance from the water" (*Owen*).

to the anterior extremity of the pelvic cavity" (*Macalister*). It is obvious that non-descent cannot be ascribed to the serious risk of injury that externality would involve (for, unlike as in the mammals, the position of the proportionately thin legs and the absence of a tail ensure no protection from external influences), since such an explanation is negatived by the present position of the testes. However, if the several characteristics of the mammalian gallop be called to mind, it is easy to afford an explanation of this apparently anomalous instance of the non-transposition of the testes. For, as I shall show, the bipedal progression of the Ostrich does not involve impulsive upheavals of the body to anything like the same extent as in the gallop of a mammal. The great upward impulses associated with the upheavals of the mammalian body are in large part due to the elongation of the trunk, for the depression of one half of the body is largely accelerated by the impetus imparted to it on the sudden elevation of the other half. That is, the upheaval of one half of the body rotates the whole length of the trunk about its centre of gravity, and so causes the other half to descend with greater acceleration than it would do under the sole influence of gravity. Hence the marked intensity of the contacts of the limbs with the earth, which have not only to destroy the downward velocity due to gravity, and the additional downward velocity due to this lever-like action of the trunk as a whole, but have also to impart an upward velocity equal in amount to the two it has neutralised. In the Ostrich, on the other hand, there is no elongated trunk possessing two pairs of limbs, and hence there can be none of that lever-action just described. Moreover, the individual elevations of the body are small compared with those of mammals, owing to the alternate action of the limbs (*cf.* the Kangaroo, in which the action of the limbs is not alternate, and in which the elevations are consequently great). And lastly, the gliding motion adopted by the Ostrich in running is yet another factor tending to diminish the intensity of the involved concussions. Hence for these three reasons the individual impulsive accelerations imparted to the body of the Ostrich are very small compared with those which exist in the case of mammals; and therefore it can easily be understood how it is that, despite the terrestrial locomotion and the perpendicular limbs, the testes have not descended in this instance. It is also possible that the posterior extension of the sternum and ribs in the struthious trunk, leading to tight packing of the viscera, so serves as a support for the testes (and other organs), but whether this is the case can only be determined by referring to the facts.

In conclusion, it will not be out of place to here give a brief summary of the entire argument concerning the cause of the descent of the testes, since it will show how strong is the probability of the theory advanced. We have seen that in mammals alone there exists a mechanical cause competent to effect transposition. If any doubt remains in the mind of the reader as to

the competency of this alleged cause, contemplation of the actual locomotion of a horse or dog, or reference to the works of Marey, Pettigrew, and others will soon dispel it. Further, I have shown that the degree of transposition of the testes corresponds

Text-fig. 57.

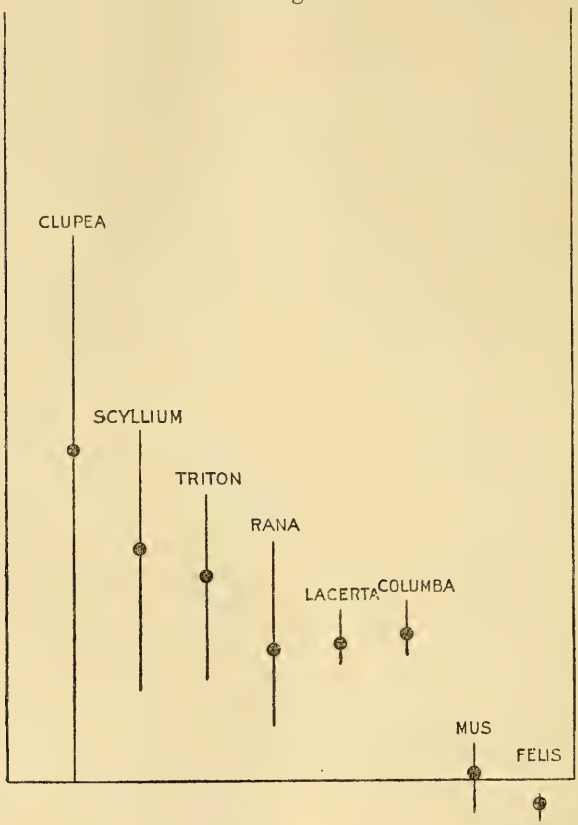


Diagram illustrating Testis Descent.

This diagram, based on a series of measurements, illustrates the positions and lengths of the testes relatively to the length of the trunk proper (minus tail) in *Clupea, Scyllium, Triton, Rana, Lacerta* (*muralis*), *Columba*, the common mouse, and the cat, all measurements being reduced to one scale. The vertical sides of the rectangle represent the length of the animal to which the other measurements are proportional, and the dots the approximate positions of the centres of gravity of the testes. Such a figure well exhibits the concentration and transposition corresponding to higher grades of impulsiveness. To fully illustrate the relationship a similar diagram drawn up from several hundred dissections is necessary, together with the average weight of the testis and intensity of the reactions incurred in locomotion, appended in the case of each animal.

to the intensity of the forces concerned, and have thus supplied the inductive evidence required to verify the conclusion arrived at on *à priori* grounds. It has also been pointed out that transposition of the testes can, from the nature of the function of these organs, the mode of emission of their genital products, and the absence of adverse external influences, neither cause derangements in the individual economy nor impair the fertility of the race; and that in consequence of a similar change of position in the case of other organs inevitably entailing one or other of these penalties, the testes alone have descended. Moreover, the superior density, the disposition of the attachment, and the appropriateness both as regards volume and definiteness and concentration of form for change of position, appertaining to the testes, lend greater additional facilities to their transposition than in the case of other organs not so characterised. Hence we can not only show why the testes have descended, but also why they alone have thus responded to the incident forces—other organs, for one or more of the reasons supplied, requiring to be maintained in position by the special retentive structures developed to that end. Combining with these facts the additional evidence derived from a study of mammalian anatomy, showing that impulsive locomotion is not alone responsible for the descent of the testes, but that it has also been the prime cause of the evolution of the diaphragm, the metanephric kidney, and other minor anatomical features, we see still more clearly "how strong is the probability of the theory advanced."

Other Illustrations of the Relationship between Visceral Conformation and Impulsiveness: the Evolution of the Diaphragm and the Metanephric Kidney.

Although differing from the reproductive elements of the body as regards their economic relations to the rest of the organism, the non-reproductive organs, possessing like material properties, may be expected to portray similar structural characteristics in relation to locomotor impulsiveness. A consideration of such will not only prove of utility as affording indirect confirmation of the foregoing, but will provide opportunity for tendering similar explanations in the case of other anatomical features. The constant interrelations of position obtaining between the various organs in the vertebrate body are in every case easily accounted for, either on mechanical or physiological grounds, and it is needless to discuss every organ from these points of view; it will suffice if we treat of two or three structural phenomena, the interpretation of which is not quite so self-evident or well known.

The complete descent of the testes and the presence of a fully-developed diaphragm both being common characteristics of the Mammalia, it is possible that the cause to which the former is attributable may also suffice to explain the evolution of the latter,

and enquiry confirms the supposition. Though, in the above account of mammalian locomotion, most stress has been laid upon the impulsive elevations of the body and resulting strains on the attachments of organs, yet it must not on that account be inferred that on descent of either half of the trunk the shock consequent on contact of the limbs with the earth (equal in intensity to the elevatory impulse) is negligible. (See above in case of Kangaroo in which it is taken into account.) Such shocks have the effect of causing those viscera which are closely adherent to the mass of the body either to exert a considerable pressure on structures anterior to them or to be dislodged from their normal position; and if in either case such a result is to be avoided, organs of support must be developed. In mammals, the lungs together with the heart occupy the anterior portion of the cœlomic cavity, and behind these are situated the liver, stomach, and intestines, these together constituting a considerable mass. These massive organs, unless prevented, would on each contact of the limbs with the earth exert great pressure on the fragile compressible lungs immediately anterior to them. Hence, in order to obviate ensuing derangements, we find in all mammals, and in many other terrestrial animals, a stout partition separating the cavity of the liver and gut from the cavity of the lungs—a structure which can only have been originated by natural selection. Evidence supporting the conclusion that the diaphragm arose as an adaptation to the forward pressure of the liver and gastric mass, is not only to be found in the fact that the diaphragm is convex anteriorly, but also in that the convexity is, *cæteris paribus*, proportional to the impulsiveness of the animal's activity and to the mass of the liver and gut. In herbivores the mass of the gut is greater than in carnivores; on the other hand, "carnivorous (fat-eating) animals generally possess a larger liver than herbivores" (*Wiedersheim*), so that these respective characters tend to defeat comparison[1]. But in the Perissodactyla we find a fairly large liver (considerably larger than in Artiodactyla), a long herbivoran gut, and a high degree of impulsiveness, the combination of which on our hypothesis should be correlated with a highly convex diaphragm—an inference which proves correct. Owen remarks that "in the perissodactyle Ungulates, in which the movable ribs are numerous and continued to near the pelvis, the diaphragm is also extensive and much arched towards the thorax"—indicating that the convexity of the diaphragm is markedly above the normal. And, doubtless, other illustrations are adducible. Additional evidence as to the primary function of the diaphragm is, moreover, afforded by the case of the Struthiones (and allies) which have adopted the mammalian mode of locomotion. In these birds there exists a "well-marked diaphragm forming a partition which divides the thoracic cavity into two parts, one posterior and small containing the lungs, and the other anterior and large containing the heart

[1] The small capacity of the herbivoran thoracic cavity as compared with that of the carnivora must be remembered in this connection.

and liver. It is a fibrous membrane, concave forwards, with a muscular attachment at either side to the ribs and intercostal tissues, which it joins in about the middle of their course. . . . . The pleural cavity is closed above and below by the fibrous diaphragm becoming blended with the first and last ribs. The anterior thoracic cavity, which contains the pericardium-coated heart in its upper part, entirely independent of the pleural cavity, is divided into two by a dense fibrous membrane which springs from two vertebral crura, much as the human diaphragm, and extends above the line to join the sternum along the border which articulates with the ribs, leaving the heart entirely in front of it; its concavity is directed downwards and forwards, and it is separated from the diaphragm proper by very large air-cells. The liver is completely separated from the abdominal cavity by a fibrous membrane, so that when the included viscera are removed, it is not at all brought into view. The mesentery is very dense and strong" (*Garrod & Darwin*). A comparison of the struthious and mammalian diaphragms affords further confirmation. In the Ostrich, owing to the anomalous position of the avian lungs (their close application to the costal skeleton ensuring the intactness of the air-cell connections), the liver has practically assumed their rôle, as regards conformation, in relation to the heart and diaphragm. Hence the diaphragm is concave anteriorly, consequent on the necessity for the retention of the liver. In the mammal, on the other hand, the lungs are of large volume and freely suspended in the ventral portion of the thorax, enveloping the heart. If the liver were anterior to the diaphragm it would, as before remarked, during locomotion periodically exert great pressure on the lungs; hence the diaphragm here becomes the forward support of the liver and other alimentary viscera. The envelopment of the heart by the liver in the Ostrich possibly affords an illustration of that alternative to the formation of a diaphragm above referred to.

From these and other considerations, we can more precisely interpret the anterior convexity of the diaphragm, which is due to two causes: the forward pressure in the median line of the large abdominal viscera, and the backward lateral extension of the capacious lungs. Evidence as to the cooperation of this last factor is afforded by such cases as that of the Manatee, in which, on account of its subaqueous habits, unusually developed organs of respiration are required, it also being essential that their extension should be dorsal in order to ensure the ventral situation of the centre of gravity of the body. Here, as Mivart remarks, the diaphragm is so oblique that the thorax "extends backwards above the whole length of the abdominal viscera"; and a similar conformation is found in Cetacea and perhaps other groups. In development, the diaphragm is "formed from a couple of septa, dorsal and ventral respectively, which arise independently, and are for some time quite distinct from each other" (*Marshall*): from which fact it follows that the part the diaphragm plays in

connection with respiration cannot have constituted its primitive *raison d'être*.

Thus, observing the necessity for the development of the diaphragm, we find that its variations in disposition and contour found in the Struthiones and Mammalian orders fully confirm the conclusion deduced on *a priori* grounds.

Another organ which, though not peculiar to the Mammalia, is yet a diagnostic feature of terrestrial vertebrates, is the metanephric kidney, and that there is possibly a relationship between terrestrial modes of locomotion and the evolution of this organ I will now endeavour to show.

It is well established that the metanephros is a development of the definitive mesonephros which has lost its nephrostomata, acquired a separate duct, and become more or less concentrated in form. It has been pointed out above that concentration of structure is an essential concomitant of that increase of impulsiveness which results from the increased activity of the animal under conditions which involve marked reactions between the body and the medium or substratum. That this is so in the case of the kidney, it is only necessary to compare the elongated mesonephric bodies of Pisces and aquatic Urodeles with the same organs of the terrestrial Amphibia and the metanephric bodies of Reptilia, and again to compare these latter with their representatives in Mammalia, in which both concentration of structure and impulsiveness of locomotion attain their maxima. With regard to the loss of nephrostomata, the same relation holds. In all Pisces, with the exception of certain Elasmobranchii, the mesonephric bodies retain connection with the cœlom by means of the nephrostomial tubules. Whether the absence of these fragile structures in Elasmobranchs (their function with regard to the cœlom perhaps being assumed by the abdominal pores) is to be attributed to the fact that these fishes either are or are not descended from the most active members of their class (and it must be remembered that they are surface forms) is not certain, but it is possible. In the aquatic Urodeles the nephrostomes are present, but in the terrestrial Anura they have completely lost their connection with the cœlom (which latter, as in Elasmobranchs, has had to discover another means of exit for its waste products). The causal relation between disruption of the nephrostomata and the adoption of a terrestrial life is here clearly shown by the ontogeny. In the development of the frog, the mesonephros is at first in communication with the cœlom by means of the nephrostomata, but at the period of metamorphosis this connection is severed, and the kidney, becoming more concentrated, finally assumes the definite form of the adult structure. Needless to say, the metanephros of Reptilia, Aves, and Mammalia is totally devoid of nephrostomes, that of the last not possessing them at any stage of development. The division of the mesonephros into two portions, one coming into relation with the testes, and the other—the definitive mesonephros—retaining its

urinary function, is evidently a physiological phenomenon, though the ultimate structural separation of the two parts must largely be attributed to the influence of greater activity of the organism. Also the secondary development of the definitive mesonephros is indirectly due to increased activity, since the work of the excretion resulting from the latter is largely increased. In fact, the whole ontogeny of the kidney—the successive developments of the pro-, meso-, and metanephros in space and time, the differences obtaining between the pro- and mesonephric tubules, the disappearance of the pronephros, &c., &c.—can be directly or indirectly attributed to the increasing activity of the organism in the course of phylogeny, as a little thought will show.

With regard to the position of the kidney—a body of considerable mass, and in Amniota similarly disposed to the testes—no relation between such and the impulsiveness of the animal being traceable, it is evident that some other factor must be involved, and enquiry shows that the localisation of the kidney is correlated with the total activity of the animal. Excretion being facilitated by proximity to a vigorous blood-supply, we find that in active animals the kidney tends to be situated anteriorly, *i. e.* nearer the heart; on the other hand, close connection with the vent to the exterior is similarly advantageous, and in inactive animals, such as Reptilia and Urodeles, we find the kidneys situated at the posterior extremity of the cœlom.

The kidneys of mammals are retained in position by a circumambient development of areolar tissue, which usually contains much fat; support is also contributed by the "tonicity" of the muscles of the abdominal wall and by the terminal ribs.

In conclusion, I must acknowledge my indebtedness for details respecting the habits and anatomy of the mammalian orders to the following authors and works: Flower and Lydekker, Owen, Wiedersheim, Beddard and Gegenbaur, Lydekker's 'Royal Natural History,' 'Mammals' by Vogt & Specht, Schmeil's 'Textbook of Zoology,' and Allen's & Lloyd's editions of Jardine's 'Naturalist's Library.'

I also wish to thank Prof. Minchin, Mr. J. T. Cunningham, and Mr. H. S. Shelton for kindly reading through the manuscript and for making several suggestions and criticisms.

Appendix.

In respect to the non-descent of the ovary in the Mammalia, it is as well to emphasise one factor ensuring its retention. Assuming that the females of mammals are approximately as active as the males, it is evident that if the mammalian ovum had retained its yolk (*i. e.* if the mammalian ovary possessed the size and mass of that of the Sauropsida and Monotremes), the retention of the ovary within the body-cavity by the development of special ligaments, &c., would have been, if not impossible, yet extremely hazardous. And such being the case, it would obviously benefit the race if the potency of one of these two factors were decreased.

Now, under the conditions of mammalian life—conditions in which survival of the fittest attains within its limited sphere of operation a maximum degree of efficiency—it is obvious that diminution of activity would be fatal, the speed of mammals being one of the most important conditions to survival in the struggle for existence (as is shown by the fact that this trait is so highly developed in these animals); hence, a less degree of activity being prohibited, any decrease in the mass of the ovary would be of service to the organism in which it occurred. Natural selection may legitimately be supposed to operate here, since, although it has been clearly demonstrated that the higher the life of the organism the less range of application does this principle possess, yet it doubtless applies in the case of any feature which is of paramount importance, and modifications concerned with the genital structures must necessarily possess such importance. It is therefore possible, and even probable, that the loss of yolk suffered by the mammalian ovary and the alternative adoption of a placental mode of nutrition both indirectly result from that same cause of impulsive locomotion to which we have traced several other features of mammalian structure.

It may also be worth while to add that many minor features of mammalian anatomy, the significance of which is usually overlooked, are only explicable on the assumption that they are related to impulsive locomotion. Instances of these minor structures are: the accumulation of fat at the base of the heart, the fatty cushion surrounding the neck of the bladder, the fatty development about the kidney already noticed, and the various "suspensory ligaments" and other "fixative organs" referred to above, associated with the stomach, liver, and other viscera of large mass.

5. On the Geographical Distribution of Spiders of the Order Mygalomorphæ. By R. I. Pocock, F.Z.S.

[Received March 17, 1903.]

(Text-figures 58–61.)

Part I.

Introductory Remarks upon the Palæontology and the Means of Dispersal of Spiders.

(*a*) Summary of the Palæontological History of Spiders, and its bearing on the Phenomena of Distribution.

Owing to the enormous chances against the preservation of fossil Spiders in sedimentary rocks, the palæontological history of this Order is very imperfect. One or two types have been discovered in Carboniferous strata of Europe and North America (*Arthrolycosa* and *Protolycosa*), and also a fairly large number of specimens from amber and from gypsum and lacustrine deposits of Oligocene and Miocene age in those countries. But absolutely

nothing is known of the forms that inhabited the world during the enormous lapse of time represented by the Mesozoic strata, and nothing except inferentially of the types that occupied the southern countries of the world during Tertiary times.

Spiders of the type that lived in the Carboniferous period succeeded in holding their own in Europe until the Oligocene, and are represented at the present time by the genus *Liphistius*, which is restricted to the Indo-Malayan area of the Oriental Region.

Apart from the genus *Liphistius*, all existing Spiders, including the Mygalomorphæ, belong to the group Opisthothelæ. There is no evidence that this group existed in the Carboniferous period; but since most of the Oligocene and Miocene fossils belong to existing families, or sometimes indeed to existing genera, it is permissible to suppose that the Opisthothelæ originated some time during the Mesozoic epoch, and may, in fact, be coeval with the mammalia. Whether any of these hypothetical Mesozoic forms survive to the present day, it is quite impossible to say. All that palæontology allows us to infer is that during the Tertiary period there was a rich and varied spider-population spread over the Northern hemisphere, containing forms that have undergone but little metamorphosis since that date. The existence of Mygalomorphæ at that time is attested by the discovery of one form referred to *Mygale* in the gypsum-beds at Aix, and of another, *Eoatypus*, in the Eocene strata at Garnet Bay in the Isle of Wight. But since it is impossible to classify these forms with an approach to certainty in any of the existing families, their only value from the geographical standpoint is the evidence they supply that the Mygalomorphæ had come into being in Tertiary times, and were living in the Northern hemisphere.

The imperfections in our knowledge above alluded to permit only a provisional acceptance of the theories put forward in the following pages to explain the distributional phenomena of the Mygalomorphæ. But all the available evidence, little enough though it be, points to the conclusion that the Mygalomorphæ and the rest of the Opisthothelæ appeared first in the Northern hemisphere, and spread thence over the southern countries of the world.

(*b*) Means of Dispersal of Spiders, and the importance of the Mygalomorphæ from the Geographical standpoint.

It cannot be claimed that Spiders as a whole are a favourable group to study from a geographical point of view; for, although exclusively terrestrial when adult, and, like other flightless animals, dependent upon continuity of land-surfaces for migration, a great many species are known to have the power, and the instinct to put it in force, of dispersing themselves over wide areas by practising when young the habit of flight, using silk-threads as aerial floats upon which they may be carried long distances before the wind. This phenomenon is well known, and has given rise to

the belief in the existence of a 'gossamer' spider which is supposed to be the cause of the fine threads which fall from the air and carpet the fields with silk at certain times of the year. It is now known that the 'gossamer' spider is a mythical species, and that species of the most diverse habits belonging to widely different families are responsible for the floating threads. The habit is practised alike, and, so far as is known, to an equal extent, by snare-spinning forms belonging to the Argiopidæ and Theridiidæ, by hunting-spiders like the Lycosidæ and Attidæ, or by sedentary species that lurk in flowers, like the Thomisidæ.

That this method of locomotion may considerably influence the distribution of spiders may be inferred from the fact that cobwebs thrown out in this way, and affording support to little spiders, have been found at the tops of our highest buildings, and have become entangled in the rigging of ships 200 miles from land.

There are reasons for thinking, however, that the habit is for the most part restricted to phanerozoic diurnal species, namely, those that hunt their prey or spin their webs in the open; and that cryptozoic forms, that live in burrows or under stones or logs of wood, and that are for the most part nocturnal, do not indulge in it[1].

Clearly, therefore, these cryptozoic groups, in which the restrictions to dispersal are presumably the same as in other terrestrial animals which can neither fly nor swim to any distance, have more value for the establishment of geographical areas than those species with powers of dispersal analogous to flight.

Owing to the relatively large size and great weight of the newly hatched young of the Mygalomorphæ, coupled with the reduction in the number of spinning-appendages and the greater simplicity of the silk-glands, it seems probable that aerial sailing is not practised to any great extent by the members of this suborder[2]. Especially true will this be of the Avicularüidæ, a family which contains the largest spiders known of this or any other epoch, with newly-born young rivalling or excelling in size the adults of many species of the Arachnomorphæ.

Consideration of these facts, coupled with the impossibility of dealing in detail, in one paper, with the distribution of all the genera of the Araneæ, has led to the selection of the Mygalomorphæ as the fittest group to illustrate the geographical distribution of Spiders in general.

[1] Simon states that the Spider-fauna of the Sandwich Islands is composed wholly of species of the former category, with the exception of some few forms which appear to owe their presence in that Archipelago to human agency ('Fauna Hawaiiensis,' Araneæ, 1902).

[2] The young of the only known British representative of this group, namely *Atypus*, one of the smallest types of Mygalomorphæ, have been seen to scatter over small areas by this method of travelling (F. Enock, Tr. Ent. Soc. 1885).

In this connection it is instructive to remark that *Atypus* has a wider distribution than any other known genus of the suborder, ranging from Ireland and Algeria to Japan and over the Eastern (? the Western) States of North America, that is to say across the Northern hemisphere from the eastern to the western shores of the Atlantic.

Part II.

Distribution of the Families, Subfamilies, and Genera of Mygalomorphæ, *and the evidence thus supplied as to their Original Habitat and the Lines of Migration followed in Dispersal.*

Family Diplurid.æ.

The Diplurid.æ are the most widely distributed of all groups of Mygalomorphæ, being found practically all over the world to the south of about the 40th parallel of north latitude. The numerous groups, however, into which the genera fall present some features in their geographical range of considerable interest.

1. Subfamily Diplurinæ.—The genus *Brachythele*[1] is met with in the Mediterranean Region, Central Asia, and the Southern States of North America. Nearly allied to it are *Hapalothele* from Madagascar; *Brachytheliscus* from Natal; *Aname*, *Ixamatus*, *Chenistonia*, and *Dekana* from Australia and Tasmania; *Fufius* from Central and South America; *Trissothele* from Chili; *Lycinus* from the Argentine. South America is also the home of *Trechona*, *Diplura*, *Uruchus*, *Harmonicon*, and *Melodeus*.

2. Subfamily Macrothelinæ.—This subfamily is divisible into four groups.

(*a*) The Macrothelæ:—*Macrothele* occurs in Spain, China, Burma, Singapore, and Java. Nearly related are *Phyxioschæma* from Transcaspia, *Stenygrocercus* from New Caledonia and Queensland, and *Porrhothele* from New Zealand. *Ischnothele* is represented by species from India, Madagascar, S. & W. Africa, and Central and South America; and *Evagrus* is known from S. Africa and Central America, whence it extends into the Southern States of North America (Idaho).

(*b*) The Hexathelæ contain two genera—*Hexathele* from New Zealand, and *Scotinœcus* from Chili.

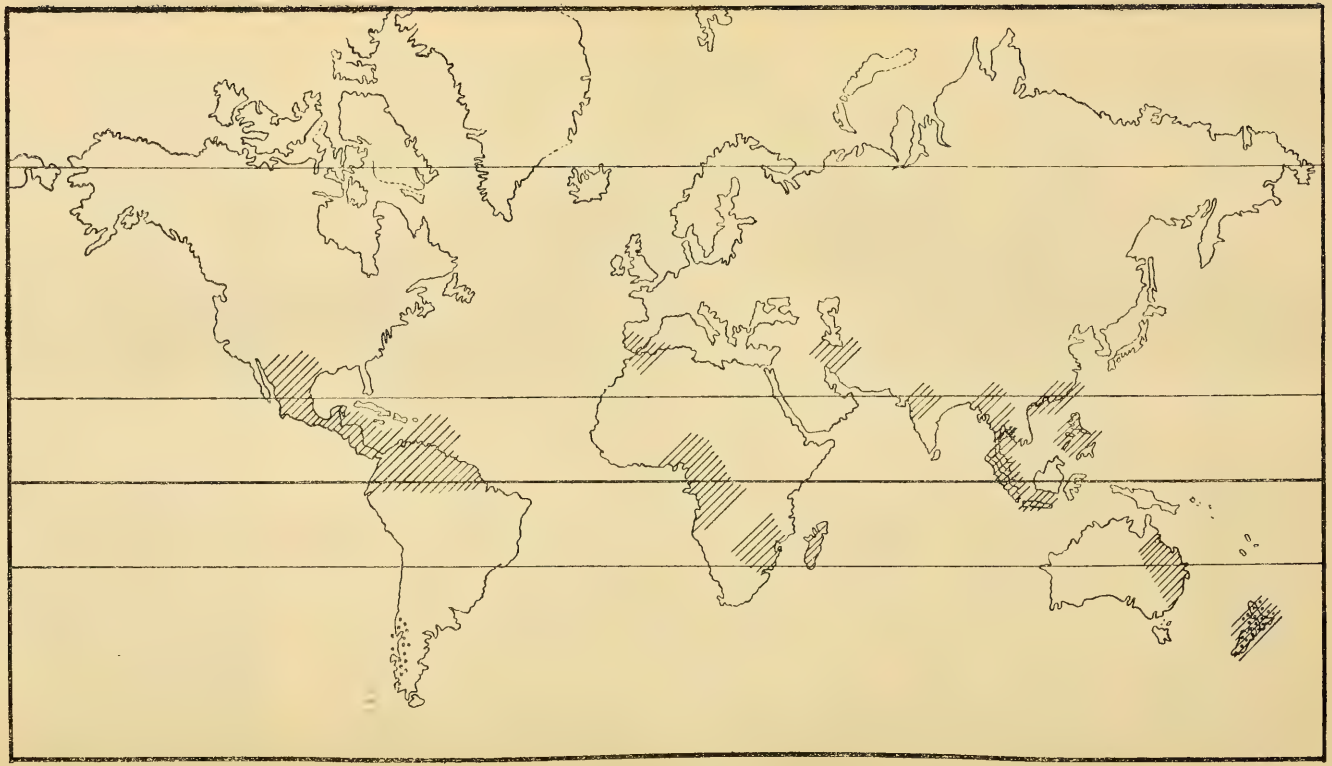
(*c*) The Atraces contain the genera *Atrax* and *Hadronyche*, from Eastern Australia.

(*d*) The Masteriæ, comprising *Accola* and *Masteria*, which are probably identical, occur in Venezuela, the Philippine Islands, and Upolu.

The presence of *Brachythele* in the Mediterranean and Sonoran areas, and of nearly allied forms in South Africa, Madagascar, and all over South America, suggests immigration from the north into these countries of the Southern hemisphere. On the other hand, the entire absence of related types from the area lying between and including India and Austro-Malaysia, and the reappearance in Australia of genera closely allied to *Brachythele*

[1] This genus has also been recorded from S. Africa, Madagascar, S. America, and Australia. It is probable, however, that the species referred to it belong to one or other of the allied genera from these areas.

Text-fig. 58.



Map to illustrate the Geographical Distribution of the Macrotheline genera of *Dipluridæ*.

Macrothelæ, Masteriæ, Atraces.

Hexathelæ.

as well as to the South-American and Afro-Mascarene forms, points equally forcibly to the peopling of Australia from either one or the other, or perhaps both, of the southern continents just mentioned.

The remaining genera of Diplurinæ, namely, *Trechona*, *Diplura*, *Harmonicon*, *Melodeus*, and *Uruchus*, all of which are more specialised types than *Brachythele* and its allies, probably arose within their present area of distribution.

A great contrast to the distribution of the Diplurinæ is presented by that of the Macrothelinæ.

The occurrence of *Macrothele* in Spain, China, Burma and Java; of *Porrhothele*, which is scarcely separable from it generically, in New Zealand; of *Phyxioschæma* in the Transcaspian area; and of its near ally, *Stenygrocercus*, in Queensland and New Caledonia, suggests a southward migration of these types from the northern provinces of the Old World into Australia and New Zealand by way of China and Indo-Malaysia. Similarly *Ischnothele*, a more specialised type than *Macrothele*, perhaps descended from the north by way of India into Madagascar, South Africa, and crossed thence into South America, where with *Evagrus*, which is also represented in South Africa, it is the only representative of this group of Dipluridæ. The entire absence from the Sonoran Region of forms related to *Macrothele*, *Evagrus*, and *Ischnothele*, is opposed to the supposition that the two last-mentioned genera had a northern origin in America.

The Masteriæ appear to be degenerate forms of the Macrothelæ. They are the smallest of all known Mygalomorphæ, and are essentially cryptozoic or lucifugous, living in caverns or under old decaying vegetation in the dark, damp forests. Hence we can only pretend to a partial knowledge of their distribution, and it would be rash to draw deductions from the fact of their having been discovered hitherto only in Venezuela, the Philippines, and Upolu.

The two genera of Atraces, *Atrax* and *Hadronyche*, confined to Australia, appear to be Macrothelinæ specialised for a fossorial life, with which is correlated certain features imparting to them a superficial similarity to the Ctenizidæ.

The Hexathelæ, resembling the Macrothelæ except in the retention of an additional pair of spinning-mamillæ, undoubtedly a primitive feature, are confined, so far as is known, to New Zealand and Chili. There seems no reason to doubt that they passed from one of these countries to the other by a southern land-connection.

Family Paratropidæ.

This family, specialised both in structure and habits, is represented by three genera, *Paratropis*, *Anisaspis*, and *Anisaspoides*, confined to the Neotropical Region. Its affinities are doubtful, but some primitive genus of Diplurida allied to *Brachythele* must

probably be looked to for its ancestry. There seems no reason to doubt that it originated in the area it now occupies.

Families Atypidæ, Brachybothriidæ, Mecicobothriidæ.

The genera of Atypidæ, two in number, scarcely pass south of the Equator. *Atypus*, occurring in the Mediterranean Region, and spreading northwards into Central Europe, beyond the 50th parallel of north latitude, is the most northern type of the Mygalomorphæ. It is also met with in Japan, Burma and Java, and in North America, where it ranges to the east of the Mississippi from Wisconsin (45th parallel of latitude) to Florida. *Calommata* is more restricted and more southern in range. It is confined to the Old World, and has been recorded from Japan, Siam, Burma, Sumatra, Java, and the Camaroon area of tropical West Africa.

The Brachybothriidæ contain the genera *Acattyma* from Japan, and *Brachybothrium* and *Atypoides* from North America, the latter from California, the former from British Columbia, North Carolina, Texas, &c.

The Mecicobothriidæ comprise two genera—*Hexura* from the two north-western States of North America (Washington and Oregon); and *Mecicobothrium* from the Argentine.

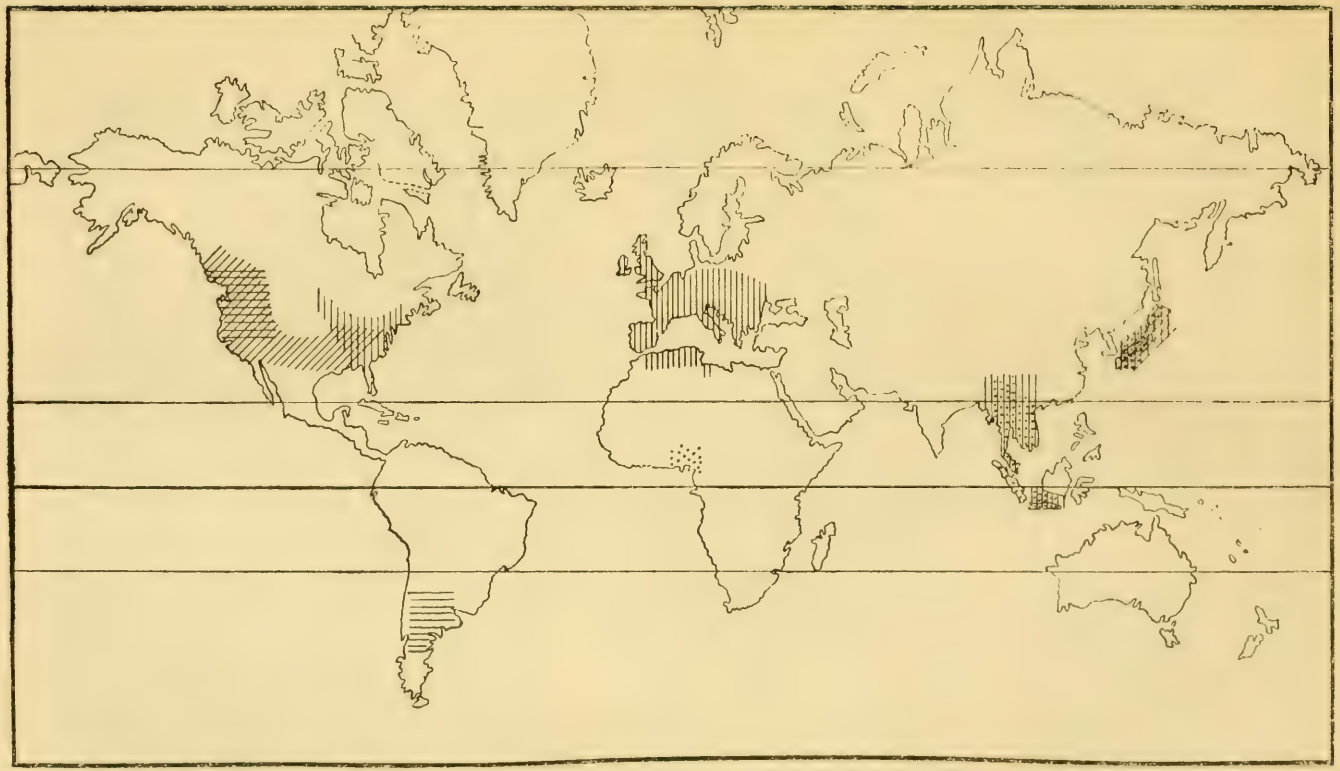
Atypus seems to be a genus which, like *Pachylomerus* and others, extended in Tertiary times sufficiently far to the north to avail itself of the land-connection that then existed across the area now covered by the Behring Sea. Its disappearance from the countries to the north of its present distributional area must be assigned to the refrigeration of this region of the globe with the advent of glacial conditions.

The distribution of *Calommata* in the eastern part of the Oriental Region and in Tropical West Africa has many parallels amongst the mammalia, and points to the former extension of the genus across an intervening forest-clad tract, and its survival in districts where the conditions remained favourable to its existence.

The explanation given of the distribution of *Atypus* applies equally to the Brachybothriidæ, except that *Atypoides* has no representative in the Old World. *Brachybothrium* extends in Western America northwards to Queen Charlotte Island, that is to say to the latitude of the Aleutian Islands and the Alaska Peninsula. Hence its similarity to, perhaps identity with, the Japanese *Acattyma* is no matter for surprise.

The apparently discontinuous distribution of the Mecicobothriidæ is very remarkable; but since the only known example of *Mecicobothrium* measures only 6 mm. in total length, it is highly probable that the existence of the genus in South America to the north of the Argentine has been overlooked. Considering the close structural similarity between *Hexura* and *Mecicobothrium*, and the admitted relationship between these two genera and the Brachybothriidæ and Atypidæ, both northern groups, it seems

Text-fig. 59.



Map to illustrate the Geographical Distribution of the *Atypidæ*, *Brachybothriidæ*, and *Mecicobothriidæ*.

probable that the Mecicobothriidæ first appeared in North America and penetrated thence into South America in the latter half of the Tertiary epoch.

The three families just discussed form an ascending series in specialisation, starting with *Hexura*, which leads from the Diplurida, passing through the Brachybothriidæ, thence to *Atypus*, and culminating with *Calommata*, the most specialised of all. Assuming, moreover, that *Acattyma* and *Brachybothrium* are identical, it is noticeable that of the six known genera, three are peculiar to the Western (American) hemisphere, two are common to both the Eastern and Western, and one only peculiar to the Eastern, namely *Calommata*. In other words, the most primitive genera are exclusively American, one that occupies an intermediate position (*Acattyma*) extends only as far as Japan, and the two genera of the most specialised Atypidæ extend from east to west throughout the Eastern hemisphere, and one of them, *Atypus*, to the extreme east of the Western hemisphere.

Since we should expect to find the primitive types of a group persisting in the area of its origin and the specialised forms in districts remote therefrom, the modifications being brought about by the varying conditions of existence incident to wandering, North America may be looked upon as the probable home of this section of the Mygalomorphæ.

If this be the explanation of their distribution, it presents analogies with that of the Camelidæ amongst the mammalia, which originated in the Sonoran area of America, and thence extended into South America and into Central Asia by way of Alaska and Kamchatka.

Family Cyrtaucheniidæ.

The genera of Cyrtaucheniidæ are exceedingly numerous, and rival the Diplurida in extent of distribution; but, owing to the complex and puzzling nature of their relationships, it is not easy to deduce any satisfactory conclusions from their distribution.

They are referable to the following sections, which are arranged as nearly as possible according to their lines of descent, starting with the most primitive, *i. e.* the Nemesiæ, which have departed least from the Diplurid type.

1. Nemesiæ.—The genus *Nemesia* itself is abundant in the Mediterranean Region, and is met with also in China; *Anemesia* occurs in Afghanistan, *Nemesiellus* in S. India, and *Scalidognathus* in Ceylon. *Hermacha*, *Hermachastes*, *Lepthereus*, *Pionothele*, and *Spiroctenus* inhabit S. Africa; *Genysa*, Madagascar; *Arbanitis*, Australia, Tasmania, and New Zealand; *Cantuaria*, New Zealand; *Rhachias*, *Carteria*, and *Hermacha* (the last also in S. Africa) in South and Central America.

2. Cyrtauchenii, differing from Nemesiæ in the procurvature of the fovea.—*Atmetochilus* and *Damarchus* occur in Burma and Sumatra; *Cyrtauchenius* and *Amblyocarenum* in the Mediterranean, the latter also in California; *Pelmatorycter* in E. and S.

Africa; *Microbatesia* in tropical W. Africa; *Stictogaster*, *Bessia*, and *Homostola* in S. Africa; *Stenoterommata*, *Pselligmus*, *Neocteniza*, *Eucteniza*, and *Enrico* in South and Central America; *Aptostichus* and *Actinoxia* in California; and *Myrmeciaphila* in Virginia and Carolina.

3. Aganippæ, differing from the preceding in the specialised arrangement of the eyes.—*Aganippe*, *Blakistonia*, *Anidiops*, *Idiosoma*—all confined to Australia.

4. Aporoptychi, differing from the Cyrtauchenii in the enlargement of the labium and maxillæ.—*Aporoptychus* and *Bolostromus* occur in tropical West Africa and South America; *Phrissæcia*, *Phæoclita*, *Celidotopus*, *Phœnothele*, and *Rhytidicolus* in S. America.

Of the above mentioned groups, that of the Nemesiæ is the only one that is represented at the present time in India, Madagascar, and New Zealand—a fact in keeping with its primitive status, and suggestive of an earlier migration into the Southern hemispheres. Singularly enough, the group is unrepresented in North America. This and the further facts that South Africa is the richest of the regions in number of genera, and that one of its genera, *Hermacha*, occurs also in Brazil, make it almost impossible to doubt that the group entered South America from South Africa. Again, since the group is also apparently absent from the whole of the area lying between India and Australia, we must look to South Africa, Madagascar, or South America as the source whence it entered Australia; and since the Mascarene genus *Genysa* is said to be nearly allied to the Australian *Arbanitis*, Madagascar and S. Africa were perhaps the feeders to the Australian area.

Since the Cyrtauchenii are specialised allies of the Nemesiæ, and therefore later developed forms, it is interesting to note their apparent absence from Madagascar, India, Australia, and New Zealand, which indicates a later southern migration from the north. The following hypothesis seems to explain the facts of their distribution. In early Tertiary times the group was continuously distributed throughout Europe, Asia, and North America. In Eastern Asia it descended a short distance into Indo-Malaya after the severance of Australia, and penetrated Africa after the formation of the Mozambique Channel. Similarly from the Sonoran Region it passed into Central and South America, after the Pliocene union of the latter with North America. Whether any of the South-American fauna was derived from Africa or *vice versâ*, there is no reliable evidence to show.

If the Aganippæ entered Australia from South-eastern Asia, it is strange that no related forms have been discovered in Austro-Malaysia. They may have come from South America or South Africa; but I am disposed to think that they have had an origin independent of the Cyrtauchenii in Australia from the Nemesiæ, from which they differ practically only in the procurvature of the fovea—a feature which is known to have arisen more than once

within the limits of the Mygalomorphæ. This conclusion as to their descent is supported by the fact that the specialised arrangement of the eyes is foreshadowed in *Dyarcyops*, one of the Nemesiæ, and by the presence of a single row of ungual pectinations in the Aganippæ and all the Australian Nemesiæ, two such rows being characteristic at least of the southern forms of the Cyrtauchenii.

The Aporoptychi are specialised Cyrtauchenii. Their distribution suggests that they originated in South America or South Africa, and crossed from the one continent to the other when the two were united. This conclusion is strongly supported by the occurrence of two of the genera in both of the areas in question.

Family Ctenizidæ.

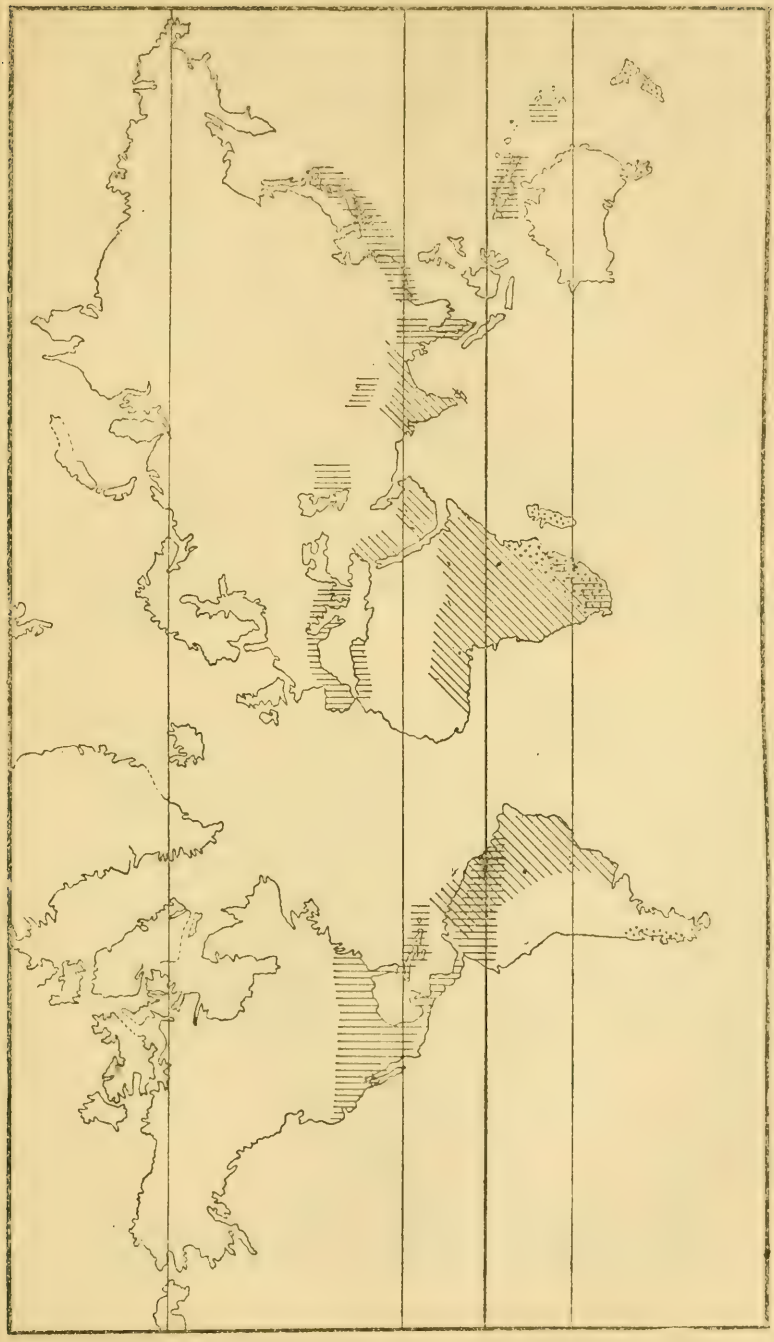
The genera of the subfamily Ctenizinæ are almost exclusively northern. *Cteniza*, *Æpycephalus*, and *Cyrtocarenum* are restricted to the Mediterranean; *Sterrhochrotus* occurs in Turkestan; *Latouchia* in China and the Himalayas; *Pachylomerus* in Spain, Algeria, Japan, N., Central, and S. America, and the West Indies; *Bothriocyrtum* in California; *Conothele* ranges from Burma to the Solomon Islands. The only genus which is exclusively southern is *Stasimopus*, which is confined to S. Africa.

The structural features of this group suggest that it is a specialised offshoot from some northern forms of the Cyrtaucheniidæ. This conclusion is borne out by the more restricted distribution of the genera, which, in virtue of their later appearance in the Northern hemisphere, have had less time to distribute themselves over the southern continents. The only genus which has entered the Ethiopian Region, namely *Stasimopus*, appears to have done so not earlier than the Pliocene, since it is seemingly not represented in Madagascar. *Conothele*, too, seems to have migrated southwards by way of Burma to the Solomon Islands, after the separation of Australia; *Pachylomerus*, the only form which enters the Neotropical Region, appears almost certainly to be a northern immigrant from the Sonoran region.

The Idiopine section, apparently a specialised offshoot of the Ctenizinæ, has, on the contrary, a more southern distribution than the typical Ctenizinæ. The genus *Idiops* (*Acanthodon*) itself has representatives in Central Asia, Syria, Arabia, India and Burma, Tropical and South Africa, and S. America; *Heligmomerus* occurs in India, Ceylon, and Tropical Africa; *Gorgyrella* in S. Africa; while the aberrant *Pseudidiops* is confined to the forests of South America.

The presence of the genus *Idiops* so far north as Central Asia and Syria, and in India, Burma, Tropical and Southern Africa, and Brazil, attesting as it does considerable powers of adaptation to varied climatic and other physical conditions, justifies the supposition that the genus never formed part of the Sonoran fauna of America. Otherwise it would be difficult to account for

Text-fig. 60.



Map to illustrate the Geographical Distribution of the *Chalcidae* and *Nigidae*.

its absence at the present time from this region, as well as from the West Indies and Central America. These considerations justify the view that South America acquired this element in its fauna, not from North America but from Africa. But by whatever route *Idiops* reached South America, it is probable that *Pseudidiops*, a specialised offshoot of that genus, arose within the Neotropical Region.

Family Halonoproctidæ.

The three known genera of this family, a specialised offshoot of the Ctenizidæ, namely, *Halonoproctus* from China, *Chorizops* and *Cyclocosmia* from the Sonoran Region, also constitute a northern group, which has not migrated into the southern continents.

Family Actinopodidæ.

Of the two genera of this family, *Eriodon* (*Missulena*) is restricted to Australia, and *Actinopus* to the Neotropical Region.

The descent of this family is doubtful, but its structure and distribution suggest its origin in the Southern hemisphere from the Cyrtaucheniidæ of the group Aporoptychi, which exist in South America and South Africa. Its present distribution may be accounted for on the hypothesis of the migration of the ancestral form either from Africa to Australia and thence to South America, or the other way about.

Family Migidæ.

The Migidæ are essentially a southern group. Two or three genera (*Myrtale* and *Thyropœus*) occur in Madagascar; *Moggridgea* in Sokotra, Nyasaland, Natal, and Cape Colony; *Heteromigas* in Tasmania; *Migas*, nearly related to *Moggridgea*, in New Zealand; and an undescribed genus, close to *Heteromigas*, in Chili.

The recurvature of the thoracic fovea in this family suggests its descent from Cyrtaucheniidæ of the section Nemesiæ, an ancient and very widely distributed group, with representatives in South Africa, Madagascar, South America, Australia, and New Zealand, the countries to which the Migidæ are now restricted. The distribution of the latter attests not only a southern origin, perhaps in the Afro-Mascarene area, but also migration thence to Australia and New Zealand, and from Australia to South America.

Family Barychelidæ.

The genera of this family fall into three sections, which may be arranged in order of specialisation as follows:—

a. Barycheli: *Leptopelma*, Mediterranean Region; *Atrophothele*, Sokotra; *Eubrachythele*, Somaliland; *Cyphonisia*, W. Africa; *Pisenor*, E. Africa; *Brachionopus*, Cape Colony; *Tigidia*,

Mauritius; *Sasonichus*, S. India; *Sipalolasma* and *Plagiobothrus*, Ceylon; *Encyocrypta*, Singapore to Australia; *Barychelus*, New Caledonia; *Idioctis*, Upolu; *Idiommata* and *Trittame*, Australia; *Psalistops*, *Stothis*, *Euthycælus*, *Epipedesis*, *Cosmopelma*, *Trichopelma*, *? Acanthogonatus*, *Homœoplacis*, *Idiophthalma*, *Strophœus*, *Cyrtogrammomma*, Neotropical Region.

b. Diplothelæ: *Diplothele*, India and Ceylon; *Forsythula*, Madagascar.

c. Sasones: *Sason*, Seychelles, Maldives, Ceylon, India, and Celebes; *? Rianus*, Pinang.

The existence of a primitive type, *Leptopelma*, in the Mediterranean area, and the entire absence of the group from the Sonoran Region and from China, suggest its origin in the western part of the Old World. Moreover, the presence of genera in Sokotra, Mauritius, Madagascar, and all over the Ethiopian Region attests a southern migration at a very early date. Similarly, the extension of the group over the Oriental Region, from India to Australia, suggests a perhaps contemporaneous movement in a south-easterly direction over the area in question, after the isolation of New Zealand. Again, the absence of genera of this family from the Sonoran Region, coupled with the relationship between the Mediterranean genus *Leptopelma* and many of the Neotropical types on the one hand, and between the remainder of the latter and the Tropical African genera on the other, points to a transatlantic connection between Africa and Europe and South America. At the same time, the possibility of a migration into South America from Australia across the area of the Pacific must be borne in mind.

In the absence of evidence to the contrary, the genus *Sason*, specialised both in structure and habits, may be regarded as having arisen from a primitive type in the area it at present occupies. That this must have taken place in very early times, before the severance of the Seychelles from India and Ceylon, would be an unavoidable conclusion, were we sure of the distinctness of the Seychellesian from the Ceylonese species. But the occurrence of one of the Ceylonese species in the Maldives proves, I think, artificial introduction into that Archipelago; and the same explanation may apply to the presence of the genus in the Seychelles.

One other point of interest remains, and that is the unquestionably close relationship that obtains between the Indian and Ceylonese genus *Diplothele* and the Mascarene *Forsythula*, the latter being a more specialised type. This is almost the only undoubted case of similarity between the faunas of Madagascar and India that the Mygalomorphæ supply.

Family Aviculariidæ.

The distribution of this family is most instructive.

The heterogeneous group of genera associated together as

Avicularinæ is represented in the Mediterranean area by the primitive genus *Ischnocolus*, which ranges from Spain and Algeria to Syria, and perhaps also occurs in Burma; by *Chætopelma* and *Cratorrhagus*, which are perhaps identical, found in the eastern countries of this sea; in India by the genera *Phlogiodes*, *Plesiophrictus*, and *Heterophrictus*; and in tropical West Africa by *Scodra*, *Heteroscodra*, *Selenogyrus*, *Heterothele*, and *Solenothele*. In America the group is represented by a wealth of genera ranging from the Southern States of the Union (Sonoran), throughout the West Indies and over the whole of S. America to Chili and the Argentine. It is necessary to mention only a few of the principal genera, such as *Aphonopelma* from the Sonoran, *Brachypelma*, *Cyrtopholis*, *Hapalopus*, *Acanthoscurria*, *Lasiodora*, *Pamphobeteus*, *Avicularia*, *Tapinauchenius*, *Citharoscelus*, *Metriopelma*, *Theraphosia*, &c. &c.

The Selenocosmiinæ range from India and Ceylon over the Indo- and Austro-Malayan Islands and Australia; the principal genera being *Pœcilotheria*, confined to India and Ceylon; *Chilobrachys*, occurring in India, Ceylon, and Burma; *Lyrognathus* in Assam; *Selenocosmia*, extending from the Himalayas into Australia; and *Selenotypus* and *Selenotholus*, which are confined to Australia.

The Thrigmopœinæ, represented by *Thrigmopœus* and *Haploclastus*, are confined to S. India.

The Ornithoctoninæ—*Cyriopagopus*, *Melopœus*, *Ornithoctonus*, *Phormingochilus*, *Citharognathus*—extend from Burma to the Moluccas.

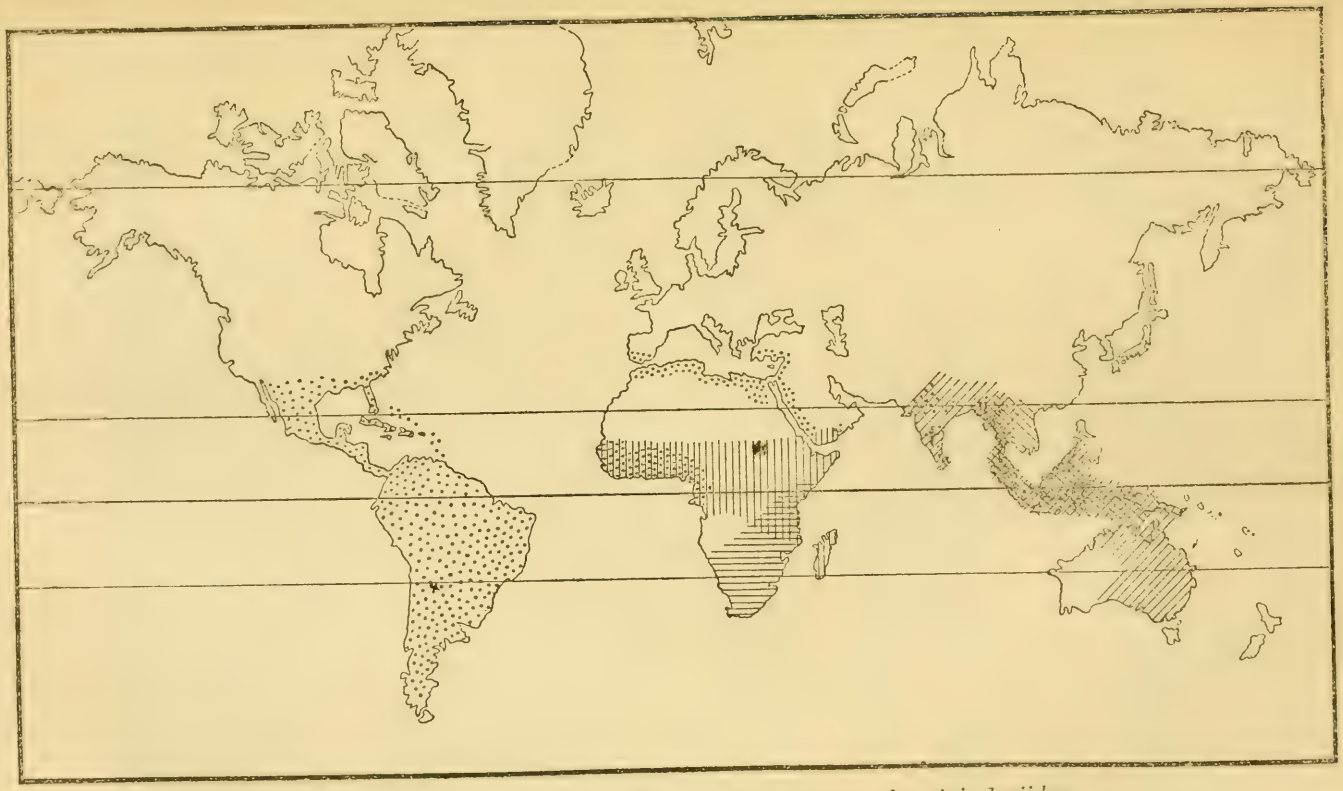
The Eumenophorinæ, containing the genera *Eumenophorus* from Sierra Leone, *Hysterocrates* from the Congo, &c., *Phoneyusa* and *Pelinobius* from the Congo and Masailand, *Batesiella* from the Camaroons, *Citharischius* and *Anoploscelus* from British East Africa, *Monocentropus* from Sokotra and S. Arabia, and *Encyocrates* from Madagascar, are thus restricted to Madagascar and the northern portions of the Ethiopian Region, since they do not appear to pass south of the Congo or the Zambesi.

The Harpactirinæ, on the contrary, are confined to South and East Africa, ranging from Masailand to Cape Colony, and crossing the area of the Eumenophorinæ north of the Zambesi. The principal genera are *Pterinochilus*, *Eucratoscelus*, *Ceratogyrus*, *Cœlogenium*, *Harpactirella*, and *Harpactira*.

Of the above-mentioned subfamilies the least specialised is that of the Avicularinæ, which contains genera like *Heterothele* and *Mitothele*, serving to link in a measure the Avicularidæ with the Macrotheline Dipluridæ. It is, moreover, the most widely distributed and most northerly in its range of all the subfamilies, and far the richest and most diversified in its genera.

Certain facts point to the conclusion that the Selenocosmiinæ originated in South-eastern Asia. The two most primitive genera of the subfamily, *Phlogiellus* and *Selenocosmia*, occur at the

Text-fig. 61.



Map to illustrate the Geographical Distribution of the *Avicularioidæ*.

Aviculariinæ. *Eamesiophorinæ.* *Harpactirinæ.* *Selenocosmiinæ.* *Ornithoctoninæ.* *Theraphosinæ.*

present time in this area, the former in Java and the Nicobars, the latter all over the Indo- and Austro-Malayan Islands and Australia. *Selenocosmia*, which must be regarded as a direct descendant of *Phlogiellus*, must itself be looked upon as the ancestor of the Malayan *Coremiocnemis*, the Assamese *Lyrognathus*, the Burmese, Indian, and Ceylonese *Chilobrachys*, and of the two Australian genera *Selenotypus* and *Selenotholus*, all of which, in the absence of evidence to the contrary, may be held to have originated within the areas of their present distribution. The affinities of the aberrant genus, *Pœcilotheria*, which is specialised both in structure and habits, are more doubtful; but there is no evidence against the hypothesis that it has been evolved in India itself.

The presence of *Pœcilotheria* and *Chilobrachys* in Ceylon and India attests their occupation of the latter area before the severance of Ceylon; and the extension of *Selenocosmia* into Australia but not into New Zealand, similarly attests a southern migration into the former country before its separation from South-eastern Asia, but after the isolation of New Zealand. It seems probable, indeed, that this southern immigration into Australia synchronised with that of the ancestors of the Australian marsupial mammals, and in this connection it is significant to note that the latter are believed to have originated in South-eastern Asia[1] and to have entered Australia in Eocene times. The great difference, however, in distribution between the Marsupials and Selenocosmiinæ may be explained by the survival of the latter, and the extinction of the former, in the area of their birth.

The Thrigmopœinæ, which are confined, so far as is known, to India, appear to have been developed from the Avicullariine stock at a late date, namely after the depression of the connecting land with Ceylon; and the Ornithoctoninæ, which range from Siam and Burma to the Moluccas, seem similarly to have put in an appearance after the separation of Australia from the continent to the north of it.

The Eumenophorinæ must have entered or been developed in the Ethiopian Region at an early date, antecedent to the separation of South Arabia and Sokotra from what is now Somaliland, and before the formation of the Mozambique Channel divided Madagascar from East Africa.

The Harpactirinæ, on the contrary, which range from Somaliland to Cape Colony but are unknown in Madagascar, seem to have originated independently within the Ethiopian Region subsequent to the Miocene period. The least specialised of the genera (*Harpactirella* and *Pterinochilus*) have not departed far from the type of structure found in the Avicullariinæ.

There remains the South-American fauna to be accounted for.

Owing to the general similarity that obtains between the genera of this area and those of other parts of the world, the

[1] Lydekker, 'Geogr. Hist. Mammals,' p. 55 (1896).

differences in extremest cases being merely accorded subfamily rank and in others only generic rank, it is hard to believe that the ancestors of the existing fauna entered South America from North America in the early part of the Secondary Period, that is to say in pre-Jurassic times, and that they have been isolated since that date until the close of the Miocene. Again, if it be supposed that they passed southwards from the north after the union of the two Americas with the close of the Miocene, the conclusion is inevitable either that the wealth of genera now existing in South America has been evolved since that date, or that there has been such a wholesale destruction of genera in the north as to leave but one genus (*Aphonopelma*) in the Southern States of N. America at the present day [1].

The occurrence of this genus in the area in question may be equally well attributed to migration of its ancestors northwards into the Sonoran Region after the union of North and South America at the close of the Miocene.

Again, since no members of the Avicularinæ occur at the present time in Australia or Austro-Malaysia, it is needless to look to this area as the source of the South-American fauna of this subfamily.

Africa, therefore, and the Mediterranean area alone remain as the centres whence the incursion could have taken place. In support of the view that preference in this connection should be given to Tropical Africa may be urged the following facts. The Avicularinæ of this region are confined to the forest-region of West Africa, which is roughly conterminous with the basin of the Congo and includes also the forest-covered district to the north of the Gulf of Guinea, and are unknown in South Africa. Secondly, the West-African genus *Scodra* is apparently the nearest living ally of the Brazilian genus *Avicularia*; and *Heterothele* and *Solenothele*, from the same region as *Scodra*, are equally nearly related, especially the former, to the Patagonian *Mitothele*.

Perhaps also some significance must be attached to the circumstance that the stridulating-organ which attains such a state of perfection in the Eumenophorinæ is represented in an imperfect and unspecialised state in many of the South-American genera of Avicularinæ.

Summary of the preceding pages.

In very early Tertiary times, or, perhaps, still earlier, the primitive Macrotheline Dipluridæ arose in Eastern Asia and spread thence in four directions:—(1) South-eastwards into Australia and New

[1] Three other genera, namely *Rhechostica*, *Tapinauchenius*, and *Avicularia*, have been recorded from the Southern States of North America; the first from Texas, the second from Texas also and 'Indian Territory,' and the third from California. The generic affinities of the first are doubtful; it may indeed be referable to *Aphonopelma*. The records of the second and third have little value, since the specimens determined were immature females.

Zealand, where the most primitive type of all, *Hexathele*, still survives and whence the ancestor of its near ally, *Scotinœcus*, crossed to South America. (2) South-westwards into India, Madagascar, and Tropical Africa (*Ischnothele* and *Evagrus*), whence these genera migrated into South America, passing thence into North America in later Tertiary times. (3) North-westwards into the Mediterranean Region (*Phyxioschœma* and *Macrothele*). (4) North-eastwards into North America, to give rise to the Mecicobothriidæ.

On the other hand, the genera of Diplurinæ, which are more specialised than the Macrothelinæ, and therefore of later origin, were represented in Tertiary times by genera (*Brachythele*) both in the Sonoran and Mediterranean Regions. From the latter, perhaps in the Oligocene era, they descended into Africa and Madagascar, but do not appear to have entered the Oriental Region at all. From Africa and Madagascar they probably entered South America, and perhaps Australia also, though they may equally well have passed from South America to Australia. In later Tertiary times also it is probable that there was a commingling of Sonoran and Neotropical forms due to southward and northward migration.

The Mecicobothriidæ, which arose in the Sonoran Region from a form, like *Hexura*, allied to *Hexathele*, themselves gave rise in early Tertiary times to the Brachybothriidæ, which still exist there and have succeeded in reaching Japan (*Acattyma*), and to the Atypidæ as well, which also crossed into Eastern Asia, and thence extended westwards as far as Ireland and Algeria, and southwards into Burma and Java. In South-eastern Asia from a primitive Atypoid genus originated *Calommata*, which probably in the Pliocene extended right away from the Oriental Region into West Africa, the existing species being known only from the latter area and from Indo-Malaysia and Japan.

In later Tertiary times the Sonoran Mecicobothriidæ moved southwards into South America, where the existing genus *Mecicobothrium* met the genus *Scotinœcus*, the ancestors of which, according to my hypothesis, reached the same country by the southern route from New Zealand.

The Cyrtaucheniidæ of the primitive group Nemesiæ at an early date entered India, Africa, and Madagascar from the north, or equally likely originated in Africa itself and spread thence into the Mediterranean Region, into Madagascar and India, into South America and into the Australian Region, as is attested by the closeness of the similarity between the South-African, South-American, and Australian species, and the absence of the group from the eastern parts of the Oriental and from the Sonoran Regions. Within Australia itself they seem to have given rise to the group Aganippæ.

The explanation given above of the distribution of the Diplurine Dipluridæ applies in almost every particular to that of the Cyrtaucheniidæ of the Cyrtauchenii group, except that the latter were later in the southward movement into Africa, reaching

that region after the separation of Madagascar, and except that they have left isolated genera in Indo-Malaya. The Aporoptychi arose in Africa from the Cyrtauchenii before the severance of that country from South America.

The Actinopodidæ were perhaps evolved from an *Aporoptychus*-like form in South America, and crossed thence to Australia.

The Migidæ probably originated in the Ethiopian Region before the isolation of Sokotra and Madagascar. The similarity between the South-African and Novo-Zelandian, the Tasmanian and Patagonian genera suggests that the migration of the family from its hypothetical home took an eastward direction.

The Ctenizidæ, a specialised northern offshoot from the Cyrtauchenii, crossed during the Tertiary period from Asia to North America, and occur at the present time in the Sonoran and Mediterranean Regions. It entered South-eastern Asia after the separation of Australia; and Africa after the formation of the Mozambique Channel, but before the sinking of the connecting land with South America. In late Tertiary times the union of North and South America admitted the Sonoran and Mediterranean genus *Pachylomerus* into the Neotropical area, where it mingled with the Idiopine element that had come from Africa.

The Halonoproctidæ must similarly have crossed from America to Asia, or *vice versa*, during the Tertiary Period, since the existing genera persist at the present time in the Sonoran Region and China.

It is impossible to determine the original home of the Barychelidæ. Possibly the family originated at an early date in Africa, and became distributed all over the area they now inhabit from that centre. Possibly it arose in the northern parts of the Old World, and at an early date extended southwards into the Ethiopian, Oriental, and Australian Regions. However that may be, there seems no reason to think that the group entered the Neotropical Region from the Sonoran.

The Avicularidæ arose in the northern portion of the Old World, whence emigrants passed into the Oriental and Ethiopian Regions. From one primitive type in India sprang the Thrigmopœinæ; from another in Indo-Malaysia the Ornithoctoninæ; and from a third the Selenocosmiinæ, which distributed themselves from India, Ceylon, and the Philippine Islands into Australia, perhaps in Eocene times. In the Ethiopian Region, from a primitive type arose the Eumenophorinæ, at a sufficiently early date to reach Sokotra, S. Arabia, and Madagascar. Later on, after the severance of Madagascar, arose the Harpactirinæ. The genera of these specialised subfamilies probably supplanted to a large extent both in the Ethiopian and Oriental Regions the Aviculariinæ, but the latter attained an enormous development in South America, which they seem to have reached from Africa or possibly from Europe. With the Pliocene union of North and South America certain forms spread northwards from South America into the Sonoran Region.

Part III.

Geographical Regions and their Principal Genera.

Mediterranean Region.

Diplurida.

Diplurinæ.—*Brachythele*: Greece, Cyprus, Central Asia.

Macrothelinæ.—*Macrothele*: Spain, China, Loo Choo. *Phyxioschæma*: Transcaspia.

Brachybothriidæ.—*Acattyma*: Japan.

Atypidæ.—*Atypus*: South and Central Europe, Algeria, Japan. *Calommata*: Japan.

Cyrtaucheniidæ.—*Nemesia*: S. Europe, N. Africa, China. *Anemesia*: Afghanistan. *Cyrtauchenius*: Southern countries of Mediterranean. *Amblyocarenum*: S. Europe, N. Africa.

Ctenizidæ.—*Pachylomerus*: Spain, Algeria, Japan. *Idiops*: Syria. *Cteniza*: France, Italy. *Æpycephalus*: Sicily, Sardinia. *Cyrtocarenum*: Eastern countries of Mediterranean. *Sterrhochrotus*: Turkestan. *Latouchia*: Loo Choo Islands, China.

Halonoproctidæ.—*Halonoproctus*: China.

Barychelidæ.—*Leptopelma*: S. Italy, N. Africa.

Avicularidæ.

Aviculariinæ.—*Ischnocolus*: S. Europe, N. Africa. *Cratorrhagus* and *Chætopelma*: Eastern area of Mediterranean.

Of the above-mentioned genera, 22 in number, those belonging to the Avicularidæ and Barychelidæ are peculiar; also *Sterrhochrotus*, *Cyrtocarenum*, *Æpycephalus*, and *Cteniza* amongst the Ctenizidæ; *Cyrtauchenius*, *Anemesia*, and *Nemesia* amongst the Cyrtaucheniidæ; *Phyxioschæma* amongst the Diplurida; and perhaps *Acattyma* amongst the Brachybothriidæ. Of the others, *Brachythele* and *Amblyocarenum* are also Sonoran; *Macrothele* and *Latouchia* also Oriental; *Atypus*, Oriental and Sonoran; *Calommata*, Oriental and Ethiopian; *Pachylomerus*, Sonoran and Neotropical; *Idiops*, Oriental, Ethiopian, and Neotropical.

Thus of the 22 genera enumerated, more than half, namely 12, are peculiar. Of the rest, 4 are Sonoran and 5 Oriental, the latter, with exception of *Idiops*, occurring in the Indo-Chinese area; 2 Ethiopian and 2 Neotropical. With the Australian Region the Mediterranean has no genera in common, although *Porrhothele* and *Stenygrocercus* of the former are nearly related to *Macrothele* and *Phyxioschæma* of the latter. These data make it impossible to attach the Mediterranean area to either of the others with which it has genera in common. Hence it must be regarded as a Region apart. The only genus which extends into the Holarctic is *Atypus*.

It may be defined as the Region lying north of the Ethiopian and Oriental Regions, and south of the great mountain-chains of Europe, north of which the Mygalomorphæ, excepting *Atypus*, do not pass.

Ethiopian Region.

(Africa south of the Sahara, South Arabia (Sokotra), and Madagascar.)

Diplurida.

Diplurinæ.—*Hapalothele*: Madagascar. *Brachytheliscus*: S. Africa. } Perhaps the same.

Macrothelinæ.—*Evagrus*: S. Africa. *Ischnothele*: Madagascar, S. & W. Africa.

Atypidæ.—*Calommata*: W. Africa.

Cyrtaucheniidæ.—*Hermacha*, *Hermachastes*, *Lepthereus*, *Pionothele*, and *Spiroctenus*: S. Africa. *Genysa*: Madagascar. *Pelmatorycter*: S. Africa. *Microbatesia*: W. Africa. *Bessia*, *Stictogaster*, and *Homostola*: S. Africa. *Aporoptychus* and *Ancylotrypa*: W. Africa.

Ctenizidæ.—*Stasimopus*: S. Africa. *Idiops*: E., W., & S. Africa. *Heligmomerus*: E. & S. Africa. *Gorgyrella*: S. Africa.

Migidæ.—*Moggridgea*: S. Africa, Sokotra. *Myrtale* and *Thyropœus*: Madagascar.

Barychelidæ.—*Atrophothele*: Sokotra. *Eubrachythele*, *Pisenor*, and *Pisenorodes*: E. Africa. *Cyphonisia*: W. Africa. *Brachionopus*: S. Africa. *Forsythula*: Madagascar. *Tigidia*: Mauritius. *Sason*: Seychelles.

Avicularidæ.

Aviculariinæ.—*Scodra*, *Heteroscodra*, and *Selenogyrus*: W. Africa. *Heterothele*: W. & E. Africa. *Solenothele*: W. Africa.

Eumenophorinæ.—*Hysterocrates*: W. Africa. *Loxomphalia*: E. Africa. *Phoneyusa* and *Pelinobius*: W. & E. Africa (probably identical). *Citharischius*: E. Africa. *Batesiella*: W. Africa. *Anoploscelus*: E. Africa. *Monocentropus*: Sokotra, S. Arabia. *Encyocrates*: Madagascar.

Harpactirinæ.—*Pterinochilus*: E. & S. Africa. *Eucratoscelus*: E. Africa. *Ceratogyrus*, *Cœlogenium*, *Harpactirella*, and *Harpactira*: S. Africa.

Of the 54 above-mentioned genera, all are peculiar to the Region, with exception of *Evagrus*, *Ischnothele*, *Idiops*, and *Hermacha*, which also occur in South America; *Sason*, *Idiops*, *Ischnothele*, and *Calommata* in the Oriental Region; possibly also with the exception of *Ancylotrypa* and *Moggridgea*, if the former is identical with the South-American *Bolostromus*, and the latter with the New-Zealand *Migas*.

Apart from its distinctive genera, the Region is essentially characterised by the two subfamilies of Avicularidæ, the Eumenophorinæ and Harpactirinæ, which are peculiar.

The fauna of Madagascar does not seem to warrant the ascription of more than subregional importance to this island. Apart from the occurrence of *Ischnothele* in India and Madagascar, and the relationship between *Diplothele* and *Forsythula*,

Madagascar shows no similarity to the Oriental Region, with which Simon united it. (Trouessart, La Géogr. Zoolog. pp. 208–211, 1890.)

The African portion of the Ethiopian Region is divisible into two well-marked subregions, namely, the West-African or forest area of the Congo, which extends from the shores of the Gulf of Guinea to Uganda, and a South and East-African area. The former is essentially characterised by the presence of the Aviculariinæ, Eumenophorinæ, and Barychelidæ; the latter by the Harpactirinæ, Cyrtaucheniidæ, and Migidæ. In East Africa, north of the Zambesi, the two regions cross.

Oriental Region.

Diplurida.

Macrothelinæ.—*Macrothele*: Burma, Malacca, Java. *Ischnothele*: India.

Atypidæ.—*Atypus*: Burma, Java. *Calommata*: Burma, Siam, Java, Sumatra.

Cyrtaucheniidæ.—*Nemesiellus*: S. India. *Scalidognathus*: Ceylon. *Damarchus*: Burma, Malacca. *Atmetochilus*: Tenasserim.

Ctenizidæ.—*Idiops*: India, Burma. *Heligmomerus*: Ceylon, S. India. *Latouchia*: Himalayas. *Conothele*: Burma to Solomon Islands.

Barychelidæ.—*Diplothele*: India, Ceylon. *Sasonichus*: India (Travancore). *Plagiobothrus* and *Sipalolasma*: Ceylon. *Sason*: India, Ceylon, Saleyer. *Encyocrypta*: Malacca, Borneo, to Queensland.

Aviculariidæ.

Aviculariinæ.—*Phlogiodes* and *Heterophrictus*: India. *Plesiophrictus*: India, Ceylon, ? Burma. *Acolischnus*[1]: Burma.

Thrigmopœinæ.—*Thrigmopœus* and *Haploclastus*: Western and Southern India.

Selenocosmiinæ.—*Pœcilotheria*: India, Ceylon. *Chilobrachys*: India, Ceylon, Burma. *Selenocosmia*: Himalayas, Burma, Java, Sumatra, Borneo, New Guinea. *Phlogiellus*: Java, Nicobars. *Lyrognathus*: India (Assam). *Coremiocnemis*: Malacca. ? *Orphnœcus*: Philippine Islands.

Ornithoctoninæ.—*Ornithoctonus*: Burma. *Cyriopagopus*: Burma, Malacca. *Melopœus*: Burma, Siam. *Citharognathus*: Borneo. *Phormingochilus*: Borneo, Celebes, Moluccas.

36 genera. Characteristic of this Region, and entirely confined

[1] New name for the species from Tenasserim, described by Thorell as *Ischnocolus brevipes* (Thorell, Ann. Mus. Genova, xxxvii. p. 170, 1897; also Pocock, 'Fauna of British India: Arachnida,' p. 183), which at least differs from the typical species of *Ischnocolus* from the Mediterranean in having the tarsus of the palp short in the male.

to it, are the two subfamilies of Avicularidæ, Thrigmopœinæ and Ornithoctoninæ, while the third subfamily, Selenocosmiinæ, is common to it and the Australian Region. Moreover, all the genera of Aviculariinæ, of Cyrtaucheniidæ and Barychelidæ are peculiar, with the exception of *Encyocrypta*, belonging to the last-mentioned, which extends to Australia. *Conothele* amongst the Ctenizidæ is also peculiar, if the Solomon Islands be included. For the rest, *Macrothele* and *Atypus* occur also in the Mediterranean Region; *Calommata* in Japan and West Africa; *Ischnothele* in Madagascar, Africa, and South America; *Idiops* in Africa and South America; *Heligmomerus* in Africa; *Latouchia* in China; and *Sason* in the Seychelles.

The apparent richness of India, Ceylon, and Burma, as compared with the eastern portion of the Region, may be merely due to more extensive collecting in the former countries; or it may be attributable to failure to penetrate far into the latter before the break-up of the area into islands. Four genera only are known to cross Wallace's line, namely, *Selenocosmia*, *Phormingochilus*, *Encyocrypta*, and *Sason*; but, apart from these genera, there is no evidence to show that this channel constitutes the divisional line between the Oriental and Australian Regions.

Australian Region.

(Australia and its adjacent Islands.)

Diplurida.

Macrothelinæ.—*Stenygrocercus*: N. Caledonia, Queensland. *Porrhothele* and *Hexathele*: New Zealand. *Atrax* and *Hadronyche*: Australia.

Diplurinæ.—*Aname*, *Ixamatus*, *Chenistonia*, and *Dekana*: Australia, Tasmania.

Cyrtaucheniidæ.—*Cantuaria*: New Zealand. *Arbanitis*: New Zealand, Australia. *Dyarcyops*, *Aganippe*, *Blakistonia*, *Anidiops*, and *Idiosoma*: Australia.

Migidæ.—*Heteromigas*: Tasmania. *Migas*: New Zealand.

Actinopodidæ.—*Eriodon*: Australia.

Barychelidæ.—*Idiommata*: Australia. *Encyocrypta*: Australia, New Caledonia. *Trittame*: Australia. *Barychelus*: New Caledonia. *Idioctis*: Upolu.

Avicularidæ.

Selenocosmiinæ.—*Selenocosmia*, *Solenotholus*, and *Selenotypus*: Australia.

Of the above-mentioned 27 genera, all are peculiar to the Region with the exception of *Encyocrypta* and *Selenocosmia*, which also occur in the Oriental Region, and possibly of *Migas*, which may prove indistinguishable from the South-African *Moggridgea*.

The poverty of New Zealand in genera, and the distinctness of two of the three forms that do occur there, entitle it to subregional rank, but no more.

The Austro-Malayan Islands, which were referred by Wallace to the Australian Region, belong, according to their Arachnid fauna, to the Oriental Region—Wallace's line being practically non-existent.

Sonoran Region.

Dipluridæ.
Diplurinæ.—*Brachythele*: California, Texas, &c.
Macrothelinæ.—*Evagrus*: Idaho.
Mecicobothriidæ.—*Hexura*: Oregon and Washington State.
Brachybothriidæ.—*Brachybothrium*: From Texas and Virginia to British Columbia. *Atypoides*: California.
Atypidæ.—*Atypus*: Eastern States, from Wisconsin to Florida.
Cyrtaucheniidæ.—*Amblyocarenum*, *Aptostichus*, and *Actinoxia*: California. *Myrmeciaphila*: Carolina, Virginia.
Ctenizidæ.—*Pachylomerus*: Carolina, Alabama, &c., Mexico. *Bothriocyrtum*: California, Utah, Texas, Mexico.
Halonoproctidæ.—*Cyclocosmia*: California, Alabama. *Chorizops*: Mexico.
Avicularriidæ.
Aviculariinæ.—*Aphonopelma*: Texas, Arizona, California. And perhaps others.

Out of the above-given list of 15 genera no fewer than 10 are peculiar to the Region, all, that is to say, with the exception of *Atypus*, *Brachythele*, *Amblyocarenum*, and *Pachylomerus*, which are also present in the Mediterranean Region, and *Evagrus*, which is met with in the Neotropical and Ethiopian Regions.

This Region, including the Mexican plateau and the Southern States of the Union, extends northwards to the northern limits of the Mygalomorphæ, or at least to those of the Scorpiones and Solifugæ [1].

Neotropical Region.

(Central America south of the Mexican plateau, West Indies, Bahamas, and South America.)

The principal genera are:—

Dipluridæ.
Diplurinæ.—*Diplura*: S. America. *Uruchus*: Ecuador. *Trechona*, *Melodeus*, and *Harmonicon*: Brazil. *Fufius*: Central and South America. *Trissothele*: Chili. *Lycinus*: Argentine.
Macrothelinæ.—*Ischnothele*: Central and South America, W. Indies. *Evagrus*: Central America.
Paratropidæ.—*Paratropis*: Ecuador, Amazons. *Anisaspoides*: Amazons. *Anisaspis*: W. Indies.
Mecicobothriidæ.—*Mecicobothrium*: Argentine.

[1] Compare also in this connection the distribution on the coast of *Limulus polyphemus*, from Cape Cod to the Gulf of Mexico.

Cyrtaucheniidæ.—*Stenoterommata*: Brazil, Chili. *Pselligmus*: Brazil. *Eutychides*: Central America, Antilles. *Aporoptychus* and *Bolostromus*: S. America. *Rhytidicolus*: Venezuela. *Phrissœcia*: Ecuador. *Phœoclita* and *Celidotopus*: Venezuela. *Hermacha*: Brazil, Chili. *Carteria*: Chili. *Rhachias*: Brazil. *Neocteniza*: Central and South America. *Eucteniza* and *Enrico*: Central America.

Actinopodidæ.—*Actinopus*: Central America to the Argentine.

Ctenizidæ.—*Pachylomerus*: Central and South America, W. Indies. *Idiops* and *Pseudidiops*: S. America.

Migidæ.—(Undescribed genus): Chili.

Barychelidæ.—*Psalistops*: Venezuela. *Stothis*: Venezuela, W. Indies. *Euthycœlus* and *Epipedesis*: Venezuela. *Cosmopelma*: Brazil. *Trichopelma*: St. Domingo, Brazil. *Idiophthalma*: Brazil. *Cyrtogrammomma*: Demerara. *Homœoplacis*: Brazil.

Aviculariidæ.

Aviculariinæ.—*Mitothele*: Patagonia. *Thalerommata* and *Tmesiphantes*: Brazil. *Dryptopelma*: Ecuador. *Magulla*: Brazil. *Adranochelia* and *Chætorrhombus*: Venezuela. *Stichoplastus*: Venezuela, Trinidad. *Hapalopus*: Central and South America. *Metriopelma*: Central America to Argentine. *Cyrtopholis*: W. Indies, Bahamas, Central America. *Citharacanthus* and *Brachypelma*: Central America. *Homœomma*: Southern Brazil. *Paraphysa* and *Phryxotrichus*: Chili. *Citharoscelus*: Chili, Argentine, Brazil. *Lasiodora*: S. Brazil. *Pamphobeteus*: Ecuador, Colombia. *Phormictopus*: Hayti. *Acanthoscurria*: W. Indies to Argentine. *Sericopelma*: Panama, Cayenne. *Ephebopus*: Amazons. *Avicularia*: Brazil, W. Indies, Central America. *Tapinauchenius*: Central and South America. *Psalmopœus*: S. America.

This list of 69 genera, although incomplete, shows the Neotropical Region to be far the richest of all in point of numbers. Moreover, all are peculiar to the Region except *Pachylomerus*, which occurs also in the Sonoran and Mediterranean Regions; *Idiops*, which is also met with in Africa, India, and the Mediterranean Region; and *Hermacha*, *Aporoptychus*, possibly *Bolostromus*, *Evagrus*, and *Ischnothele*, which have been recorded from Africa, the last-named also from Madagascar and India. So too the family Paratropidæ is confined to the Region; the Mecicobothriidæ exist elsewhere only in the Sonoran Region; and the Actinopodidæ only in Australia.

Part IV.

Distribution of some of the Families of Arachnomorphæ that were represented in the Oligocene Period.

The only fossil Spiders, with one or two exceptions, of which the generic determination may be trusted, are those that have been found in the amber-beds of Oligocene age. Those that have been referred to genera not now known to exist have no special importance from a geographical standpoint; but of those that have been assigned to existing genera, the following may be taken as a fairly complete list:—*Segestria* and *Dysdera* (Dysderidæ); *Eresus* (Eresidæ); *Amaurobius* (Dictynidæ); *Aranea*, *Zilla*, *Tetragnatha*, and *Nephila* (Argiopidæ); *Archæa* (Archæidæ); *Tegenaria* and *Agelena* (Agelenidæ); *Drassus* (Drassidæ); *Clubiona*, *Anyphæna*, and *Sparassus* (Clubionidæ); *Thomisus* and *Philodromus* (Thomisidæ).

Although since the Oligocene these Spiders have had the same time for dispersal, they nevertheless differ greatly in their distribution. *Dysdera*, for example, is apparently indigenous only in the Mediterranean and central portions of Europe and Asia[1]; *Eresus* is found in South and Central Europe, Central Asia, China, and Africa to the north and south of the Sahara; *Amaurobius* all over the world with the exception of India, tropical Africa, and Madagascar; *Aranea* and *Tetragnatha* are cosmopolitan; *Nephila* is mainly restricted to the tropics and the Southern hemisphere, though in Eastern Asia it extends as far north as Japan, and in North America enters the Southern States of the Union; *Archæa* is known only from Madagascar; *Tegenaria* is indigenous apparently only in Europe and North America; *Agelena* in Europe, South Africa, India, and Burma; *Anyphæna* in North, Central, and South America (Andes), Japan, India (in the mountains), and Central Europe.

The Hersiliidæ were represented in the Oligocene of Europe. The four existing genera are distributed as follows:—*Hersilia* ranges from the southern area of the Mediterranean as far as Malaysia in the Oriental Region, and over Africa and Madagascar. Its very near ally *Murricia* is confined to India; *Hersiliola* is known only from the Mediterranean Region and S. Africa. *Tama*, next to *Hersiliola* the most primitive of all the genera, occurs in the Mediterranean, Oriental, Australian, and Neotropical Regions.

The distribution of the group offers no difficulties to the hypothesis of a southern migration from Europe. The absence of the genus *Tama* from North and Central America strongly suggests its existence in South America to be attributable to migration from Australia.

Two genera of Eresidæ have been recorded from the European

[1] Specimens that have been recorded from the Southern hemisphere are mostly, probably in all cases, referable to imported European species.

Oligocene. At the present time the family is represented by *Adonea* and *Dorceus* in the southern area of the Mediterranean; by *Dresserus* and *Seothyra* in Tropical and South Africa; by *Stegodyphus* in the Mediterranean Region, India, Ceylon, and Burma in the Oriental Region, and East and South Africa in the Ethiopian Region; by *Eresus*, which extends across Europe and Asia from England to China, being especially abundant in the Mediterranean Region and also occurs in South Africa. The absence of this group from Madagascar points to a late (probably Pliocene) incursion from the north into Africa, which, in conjunction with its failure to reach North America and Australia, also explains its absence from South America.

The only existing genus of Urocteidæ, *Uroctea*, was represented in the European Oligocene. At the present time it is found in the Mediterranean Region, China, Japan, India, and South Africa. The apparent absence of the genus from Madagascar indicates a late movement into South Africa.

The Palpimanidæ are also alleged to date back to the Oligocene. The most primitive member of the family, *Huttonia*, constituting the Huttoniinæ, is now restricted to New Zealand. The more specialised Stenochilinæ are confined to the Oriental Region, where they range from Bombay to the Philippines. The Palpimaninæ, the most specialised of the three, to which the Oligocene genus belongs, are represented by two groups, the Chedimeæ and the Palpimaneæ. The latter, containing the single genus *Palpimanus*, occurs in the Mediterranean Region, Western India, and East and South Africa; the former is represented by *Boagrus* in the Malay Peninsula, *Steriphopus* in Ceylon, *Sarascelis* in the Malay Peninsula and tropical West Africa, *Diaphorocellus* in South Africa, and by *Otiothops* and *Anisœdus* in South America. The survival of the primitive type, *Huttonia*, in New Zealand assigns great antiquity to this group. The Stenochilinæ and Palpimaninæ were perhaps evolved in South-eastern Asia and spread thence in a westerly direction, the more specialised Palpimaninæ reaching Europe in the Oligocene and passing into Africa and thence to South America. The entire absence of Palpimaninæ from North America and Australia, and the near relationship that obtains between the genera from South America and Tropical Africa, almost compels the belief that the former country received this element of its fauna from the latter.

The Anyphænidæ are represented in the Oligocene beds of Europe and North America. At the present time, one genus only, *Anyphæna*, occurs in the temperate area of the Northern hemisphere of the Old World; the same genus also occurs in North America; while the remainder of the genera, sixteen or so in number, extend into South America, principally along the Andean chain as far south as Tierra del Fuego. These facts suggest that the group had its origin in North America, perhaps in Eocene times, crossed thence into Asia and Europe before or during the Oligocene, and, when North and South America were

united at the close of the Miocene, descended into the latter area. If so, it presents a striking parallel to that of the Camel family, which was represented by many genera, now extinct, in North America during the Tertiaries, from the Lower Oligocene upwards, entered the Old World, where it is now represented by the Camels, and South America, where the Llamas still exist and extend principally along the mountains far to the south into Patagonia. Here again, as in other cases, the exact parallelism between the Mammalia cited and the Spiders fails apparently only on account of the survival of the latter and the extinction of the former in the area of their origin.

To pursue this subject further, and take all the families and genera of Spiders into consideration, would require a special volume. Enough, however, has been said to show that the suggestions put forward to explain the distribution of other groups of animals apply also to the distribution of Spiders.

Note.—During the passage of these pages through the press, Simon has issued two papers (Bull. Mus. d'Hist. Nat. 1902, pp. 595–598; Ann. Soc. Ent. Belg. xlvii. pp. 21–23, 1903) containing descriptions of the following new genera of Mygalomorphæ:—

Dipluridæ.—*Entypesa*, allied to the Australian *Ixamatus*: Madagascar.

Cyrtaucheniidæ.—*Diadocyrtus*, allied to the Ceylonese *Scalidognathus*; *Genysochœra*, near *Genysa*: Madagascar.

Ctenizidæ.—*Hebestatis*, near *Pachylomerus*: California.

Migidæ.—*Calathotarsus*, near the New-Zealand *Migas*: Chili. *Pœcilomigas*, near *Moggridgea*: S. Africa.

Barychelidæ.—(Barycheli) *Zophoryctes*, allied to the Australian *Trittame*; (Diplothelæ) *Cestotrema*, *Acropholius*: Madagascar.

The chief feature of interest is the six new genera from Madagascar, two of which are related to Australian forms, one to a Ceylonese genus, one to a previously known Mascarene genus; the remaining two belonging to the Diplothelæ, hitherto represented by two genera, one from Madagascar, the other from Ceylon and India. Reference may also be made to the new Chilian genus of Migidæ, which I have already mentioned (p. 365).

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THE END.

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The annual supply of Tickets will be sent to each Fellow on the 1st of January in every year, on his filling up a form of Standing Order stating in what way they should be made up, and to what address they should be sent. Forms for this purpose are supplied on application.

The Wife of a Fellow can exercise all these privileges in his absence.

Fellows have the privilege of receiving the Society's Publications on payment of the additional Subscription of One Guinea every year. This Subscription is due upon the 1st of January and must be paid *before* the day of the Anniversary Meeting, after which the privilege lapses. Fellows are likewise entitled to purchase the Transactions and other Publications of the Society at 25 per cent. less than the price charged to the public. A further reduction of 25 per cent. is also made upon all purchases of Publications issued prior to 1871, if above the value of Five pounds.

Fellows also have the privilege of subscribing to the Annual Volume of the Zoological Record for a sum of £1, payable on the 1st July in each year, but this privilege is forfeited unless the subscription be paid *before* the 1st of December following.

They may also obtain a Transferable Ivory Ticket admitting Two Persons, available throughout the whole period of Fellowship,

on payment of Ten Pounds in one sum. A second similar ticket may be obtained on payment of a further sum of Twenty Pounds.

Any Fellow who intends to be absent from the United Kingdom during the space of one year or more may, upon giving to the Secretary notice in *writing*, have his name placed upon the "dormant list," and will be thereupon exempt from the payment of his annual contribution during such absence.

Any Fellow, having paid all fees due to the Society, is at liberty to withdraw his name upon giving notice in *writing* to the Secretary.

Ladies or Gentlemen wishing to become Fellows of the Society are requested to communicate with the undersigned.

P. CHALMERS MITCHELL, M.A., D.Sc.,
Secretary.

3 Hanover Square, London, W.,
August, 1903.

MEETINGS

OF THE

ZOOLOGICAL SOCIETY OF LONDON

FOR

SCIENTIFIC BUSINESS.

(AT 3 HANOVER SQUARE, W.)

Session 1903–1904.

1903.

Tuesday, November 3 and 17 | Tuesday, December 1

1904.

Tuesday, January 19	Tuesday, April .. 19
,, February 2 and 16	,, May .... 3 and 17
,, March .. 1 ,, 15	,, June 7

The Chair will be taken at half-past Eight o'clock in the Evening precisely.

LIST OF THE PUBLICATIONS

OF THE

ZOOLOGICAL SOCIETY OF LONDON.

The scientific publications of the Zoological Society of London are of two kinds—"Proceedings," published in an octavo form, and "Transactions," in quarto.

According to the present arrangements, the "Proceedings" contain not only notices of all business transacted at the scientific meetings, but also all the papers read at such meetings and recommended to be published in the "Proceedings" by the Committee of Publication. A large number of coloured plates and engravings are attached to each annual volume of the "Proceedings," to illustrate the new or otherwise remarkable species of animals described in them. Amongst such illustrations, figures of the new or rare species acquired in a living state for the Society's Gardens are often given.

The "Proceedings" for each year are issued in four parts, on the first of the months of June, August, October, and April, the part published in April completing the volume for the last half of the preceding year. From January 1901 they have been issued as two half-yearly volumes.

The "Transactions" contain such of the more important communications made to the scientific meetings of the Society as, on account of the nature of the plates required to illustrate them, are better adapted for publication in the quarto form. They are issued at irregular intervals.

Fellows and Corresponding Members, upon payment of a Subscription of One Guinea *before* the day of the Anniversary Meeting in each year, are entitled to receive the Society's Publications for the year. They are likewise entitled to purchase the Publications of the Society at 25 per cent. less than the price charged for them to the Public. A further reduction of 25 per cent. is made upon purchases of Publications issued prior to 1871, if they exceed the value of five pounds.

Fellows also have the privilege of subscribing to the Annual Volume of the Zoological Record for a sum of £1 (which includes delivery in the United Kingdom *only*), payable on the 1st July in each year; but this privilege is forfeited unless the subscription be paid *before* the 1st of December following.

The following is a complete list of the publications of the Society already issued. They may be obtained at the Society's Office (3 Hanover Square, W.), at Messrs. Longmans', the Society's publishers (Paternoster Row, E.C.), or through any bookseller.

[*August*, 1903.]

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List of the Vertebrated Animals now or lately Living in the Gardens of the Zoological Society of London. (Eighth Edition.) 8vo. 1883. Price 3*s.* 6*d.*

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THE object of the Zoological Record is to give, by means of an annual Volume, complete lists of the Works and Publications relating to Zoology in all its branches that have appeared during the year preceding the issue of the Volume, together with full information as to the points they deal with, arranged in such a manner as to serve as an Index to the literature of Zoology in all parts of the globe, and thus to form a repertory that will retain its value for the Student in future years.

The 'Zoological Record' is published for the Society by Messrs. Gurney and Jackson at the price of 30*s*. per volume. But all Members of the Zoological Society of London have the privilege of receiving it, including the cost of delivery (within the United Kingdom), at a subscription price of 20*s*. per annum. This Subscription is due on the 1st of July in every year, and the privilege of Subscription is forfeited unless the amount be paid before the 1st of December following.

The Zoological Society, having purchased the entire stock of the 'Zoological Record,' is able to supply complete sets. The thirty-seven Volumes to the end of the nineteenth century, and the Index-Volume in addition, will be supplied for £15 net (or *without* the Index-Volume, for £14 10*s*. net). Volumes of any single year (exclusive of the last five volumes and Vol. 6) can likewise be supplied at 10*s*. per volume net.

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Members of the Society wishing to subscribe to the 'Record' are requested to apply at this office for a Form, to be returned when filled up and signed by the subscriber. In order to facilitate the payment of the subscription, a Banker's Order Form is also furnished to those who prefer that mode of payment. This order, when filled up and signed, should be sent to the Society's office for registration; it will then be sent to the Agents named therein.

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Commencing with Vol. xxxix., the divisions of the 'Zoological Record' may be obtained separately, as shown in the subjoined List.

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P. CHALMERS MITCHELL, M.A., D.Sc.,
Secretary.

August, 1903.

Zoological Society of London,
3 Hanover Square, W.

LIST OF VOLUMES OF THE 'ZOOLOGICAL RECORD.'

The Record of Zoological Literature, 1864–1868. Vols. I.–V. Edited by ALBERT C. L. G. GÜNTHER, M.A., M.D., Ph.D., F.Z.S., &c. Price 10*s.* each Volume net.

The Record of Zoological Literature, 1869. Volume Sixth. Edited by ALBERT C. L. G. GÜNTHER, M.A., M.D., Ph.D., F.R.S., F.Z.S., &c. London, 1870. Price 30*s.*

The Zoological Record for 1870–1872, Vols. VII.–IX. Edited by ALFRED NEWTON, M.A., F.R.S., F.L.S., V.P.Z.S., &c. Price 10*s.* each Volume net.

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The Zoological Record, Volume the Thirty-fifth; being Records of Zoological Literature relating chiefly to the year 1898. By J. A. Thomson, R. Lydekker, R. Bowdler Sharpe, G. A. Boulenger, W. A. Herdman, E. R. Sykes, E. A. Smith, G. C. Crick, A. W. Brown, D. Sharp, F. A. Bather, Florence Buchanan, R. T. Günther, and R. von Lendenfeld. Edited (for the Zoological Society of London) by DAVID SHARP, M.A., F.R.S., F.Z.S., &c. London, 1899. Price 30*s.*

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The Zoological Record, Volume the Thirty-seventh; being Records of Zoological Literature relating chiefly to the year 1900. By J. A. Thomson, R. Lydekker, R. Bowdler Sharpe, G. A. Boulenger, W. A. Herdman, E. R. Sykes, E. A. Smith, G. C. Crick, A. W. Brown, D. Sharp, F. A. Bather, A. Willey, and E. A. Minchin. Edited (for the Zoological Society of London) by David Sharp, M.A., F.R.S., F.Z.S., &c. London, 1901. Price 30*s.*

The Zoological Record, Volume the Thirty-eighth; being Records of Zoological Literature relating chiefly to the year 1901. By J. A. Thomson, R. Lydekker, R. Bowdler Sharpe, G. A. Boulenger, Alice L. Embleton, E. R. Sykes, E. A. Smith, S. Pace, Albert Brown, D. Sharp, F. A. Bather, and E. A. Minchin. Edited (for the Zoological Society of London) by David Sharp, M.A., F.R.S., F.Z.S., &c. London, 1902. Price 30*s.*

Index Zoologicus. An alphabetical list of names of genera and subgenera proposed for use in Zoology, as recorded in the Zoological Record, 1880–1900; together with other names not included in the 'Nomenclator zoologicus' of S. H. Scudder. Compiled (for the Zoological Society of London) by Charles Owen Waterhouse and edited by David Sharp, Editor of the Zoological Record. London, 1902. Price to Fellows, 18*s.* net; price to the public, 20*s.* net.

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P. CHALMERS MITCHELL, M.A., D.Sc.,
Secretary.

3 Hanover Square, London, W.,
August, 1903.

PROCEEDINGS

OF THE

GENERAL MEETINGS FOR SCIENTIFIC BUSINESS

OF THE

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OF LONDON.

1903, vol. I.

PART I.

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